

A TAXONOMIC REVISION OF CANSCORA, CRACOSNA, DUPLIPETALA, HOPPEA, MICRORPHIUM, PHYLLOCYCLUS AND SCHINZIELLA (GENTIANACEAE–CANSORINAE)

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SUMMARY

A taxonomic revision of all genera belonging to Gentianaceae–Canscorinae, i.e., *Canscora*, *Cracosna*, *Duplipetala*, *Hoppea*, *Microrhium*, *Phyllocyclus* and *Schinziella* is presented, including keys to the taxa, distribution maps and seed coat descriptions. One new genus, one new species and seven new combinations are described. In total seven genera and 23 species are recognized. All taxa are of palaeotropical distribution with centres in India and SE Asia.

Key words: Gentianaceae, *Canscora*, *Cracosna*, *Duplipetala*, *Hoppea*, *Microrhium*, *Phyllocyclus*, *Schinziella*, taxonomy.

INTRODUCTION

A molecular phylogenetic analysis of the Gentianaceae based on the plastid *matK*, *trnL*-intron and partial *rbcL* sequence data was the basis for a new classification of the family with six tribes and eight subtribes (Thiv et al., 1999a, b; Thiv, 2000; Struwe et al., 2002). On the basis of these studies, subtribe Canscorinae Thiv & Kadereit as part of tribe Chironieae (G. Don) Endl. was established (Struwe et al., 2002). The Canscorinae are characterized by their palaeotropical distribution, a calyx tube that is much longer than the lobes, tetra-, penta- or hexamerous flowers, and often anisomorphic stamens. The subtribe contains 23 species in seven genera. These are *Canscora* Lam., *Cracosna* Gagnep., *Duplipetala* Thiv, *Hoppea* Willd., *Microrhium* C.B. Clarke, *Phyllocyclus* Kurz and *Schinziella* Gilg.

Most authors in the early 19th century treated *Canscora* and *Hoppea* as members of the same tribe or subtribe (Don, 1838; Endlicher, 1838; Grisebach, 1839, 1845; Table 1). Gilg (1895) regarded the genera of Canscorinae known at that time as part of his Gentianeae–Erythraeinae together with several genera, which do not belong to this subtribe in the molecular analyses. Gilg-Benedict (1939) placed *Canscora*, *Hoppea*, and *Schinziella* in the Gentianeae–Erythraeinae–Ellipandreae, but ignored *Microrhium*, *Phyllocyclus*, and *Cracosna* although Gagnepain (1929) suspected a close relationship between the latter genus and *Canscora*.

Canscora was described by Lamarck (1785) based on *C. perfoliata*. Willdenow (1801) described *Hoppea* with *H. dichotoma*, and Kurz (1873) established *Phyllocyclus*, which was later reduced to subgeneric rank in the classification of *Canscora* by Clarke (1885). Clarke divided *Canscora* into subgenera *Canscora* Lam., *Heterocanscora*

Table 1. Classification of Canscorinae by earlier authors.

	Don (1838)	Endlicher (1838)	Grisebach (1839)	Grisebach (1845)	Bentham & Hooker (1876)	Knoblauch (1894)	Gilg (1895)	Gilg-Benedict (1939)
<i>Canscora</i>	Gentianeae-verae	Chironieae	Erythraeaceae	Chloreae-Erythraeaceae	Chironieae-Erythraeaceae	Chironieae-Erythraeaceae	Gentianeae-Erythraeinae	Gentianeae-Erythraeinae-Ellipandrae
<i>Cracosta</i>	-	-	-	-	-	-	-	-
<i>Duplipetala</i>	-	-	-	-	-	-	-	-
<i>Hoppea</i>	Gentianeae-verae	Chironieae	Erythraeaceae	Chloreae-Erythraeaceae	Chironieae-Euchironieae	Chironieae-Euchironieae	Gentianeae-Erythraeinae	Gentianeae-Erythraeinae-Ellipandrae
<i>Microrrhizum</i>	-	-	-	-	-	-	-	-
<i>Phyllocyclus</i>	-	-	-	-	Chironieae-Erythraeaceae	Chironieae-Erythraeaceae	Gentianeae-Erythraeinae	-
<i>Schinziella</i>	-	-	-	-	-	-	Gentianeae-Erythraeinae	Gentianeae-Erythraeinae-Ellipandrae

Table 2. Classification of *Canscora* by Clarke (1885, 1906).

Subgenus	Species
<i>Canscora</i>	<i>C. diffusa</i>
	<i>C. heteroclita</i>
	<i>C. alata</i>
	<i>C. concanensis</i>
	<i>C. perfoliata</i>
	<i>C. roxbughii</i>
	<i>C. andrographioides</i>
<i>Heterocanscora</i>	<i>C. schultesii</i>
<i>Phyllocyclus</i>	<i>C. helferiana</i>
	<i>C. parishii</i>
<i>Pentanthera</i>	<i>C. pentanthera</i>

(C.B. Clarke) C.B. Clarke, and *Phyllocyclus* (Kurz) C.B. Clarke. In 1895 Gilg transferred *Canscora tetragona* to a new genus, *Schinziella*. Clarke (1906) not only described the new genus *Microrphium*, but also the new subgenus *Pentanthera* C.B. Clarke of *Canscora*. The new genus *Cracosna* was established by Gagnepain (1929), its name being an anagram of *Canscora*. The majority of the 23 species of the Canscorinae were originally described as species of *Canscora*. Previously, most authors (e.g., Ridley, 1923; Ubolcholaket, 1987; Ho & Pringle, 1995) accepted Clarke's (1885, 1906) treatment of *Canscora* as a large genus comprising four subgenera (Table 2).

Because the taxonomic treatment of the Canscorinae by earlier authors was very incomplete, the generic and specific delimitations remained hitherto unclear. Therefore, the following revision provides a complete overview of the subtribe. In this paper a narrower definition of *Canscora* is preferred, and a new genus, *Duplipetala*, is described. The combination of molecular and morphological evidence (Thiv et al., 1999b; Thiv & Kadereit, 2002) leads to the recognition of three major lineages within the Canscorinae: 1. *Canscora* s.str. (= subgenera *Canscora* and *Heterocanscora*), *Hoppea*, and *Schinziella* have tetramerous flowers and an anisomorphic androecium; 2. although only weakly supported, *Cracosna*, which is characterized by the possession of tetramerous flowers, isomorphic stamens and petal nectaries, was found to be the sister group to *Canscora* s.str. / *Hoppea* / *Schinziella* (Thiv & Kadereit, 2002); 3. *Microrphium*, *Phyllocyclus* (= *Canscora* subgenus *Phyllocyclus*), and *Duplipetala* (= *Canscora* subgenus *Pentanthera*), have penta- or hexamerous flowers and an isomorphic androecium in which, however, the length of the filaments can differ.

MATERIAL AND METHODS

For the morphological studies herbarium material from A, B, BKF, BM, BO, BR, C, E, F, FWM, G, HBG, K, KLU, KUN, L, MEL, MICH, MO, NSW, NY, P, PE, PH, PNH, S, SING, SRGH, TUB, U, US and Z was used. Distribution maps were created using Online Map Creation (<http://www.aquarius.geomar.de/omc/>) and modified in Adobe Illustrator 9.0. For the SEM-photography seeds were stuck on aluminium stubs with double-sided tape and sputter-coated with gold on a Balzers SCD 004 sputter. SEM-photographs were taken on a LEITZ AMR 1200 B microscope.

TAXONOMIC TREATMENT

CANSORINAE Thiv & Kadereit in Struwe et al. (2002) 50

Annual or perennial, rarely suffrutescent, mostly erect and glabrous *herbs*; stems quadrangular or rarely terete, unwinged or often strongly winged. Rosette *leaves* present or not; cauline leaves free or rarely perfoliate, sessile or rarely petiolate. *Inflorescences* axillary or rarely terminal cymes or rarely spikes; bracts free or perfoliate. *Flowers* tetra-, penta-, or hexamerous (sometimes the number of calyx lobes reduced), sessile or pedicellate, with or without bracteoles. *Calyx* tubular, funnelshaped, campanulate or inflated urceolate, sometimes strongly winged, mostly persistent; tube much longer than lobes; calycine colleters absent. *Corolla* actinomorphic or zygomorphic (see *Canscora*), tubular, salver- or funnelshaped; tube mostly longer than lobes. *Androecium* isomorphic or anisomorphic (see genus descriptions), inserted in upper, central or lower part of corolla tube; anthers basifixed, introrse, persistent or deciduous, mostly sagittate; pollen in monads. *Ovary* of two carpels, unilocular; placentation parietal; style distinct, filiform; stigma bilobed. *Fruit* a septicidal capsule with numerous seeds. *Seeds* of various shape.

KEY TO THE GENERA OF CANSORINAE

- 1a. 1 (or rarely 2) stamen inserted at higher level than the remaining stamens, this stamen mostly with larger anther; anthers persistent. Flowers tetramerous. Mainly annuals, when perennials, flowers in dense, head-like cymes. Cauline leaves free 2
- b. All stamens inserted at the same level, anthers of equal size; caducous (except for *Cracosna*). Flowers (corolla and androecium) tetra-, penta-, or hexamerous. Annuals or perennials with flowers in lax or dense, never headlike cymes or spikes. Cauline leaves free or perfoliate 4
- 2a. Plants perennial, often suffrutescent. Corolla yellow, actinomorphic. Flowers in many-flowered headlike cymes **7. Schinziella**
- b. Plants annual, herbaceous. Corolla whitish or lilac, actinomorphic or zygomorphic. Flowers in lax or dense cymes or rarely spikes 3
- 3a. Corolla < 4.4 mm, actinomorphic, white. Stems with wings **4. Hoppea**
- b. Corolla > 5.2 mm, zygomorphic, with 2 larger lobes and 2 smaller lobes, whitish or lilac. Stems with or without wings **1. Canscora**
- 4a. Plants with bristles on green parts (peduncles, calyx base and young leaves). Calyx dimerous. Corolla pentamerous **5. Microrphium**
- b. Plants entirely glabrous. Never a combination of a dimerous calyx and a pentamerous corolla 5
- 5a. Corolla tetramerous with nectaries in the middle of the inner surface¹. Calyx tubular. Flowers in dense or lax cymes. All leaves including bracts free. Stems winged **2. Cracosna**
- b. Corolla penta- or hexamerous without nectaries. Calyx mostly urn-shaped. Flowers in lax cymes. Bracts and/or cauline leaves perfoliate or free. Stems not winged. 6

1) Nectaries are sometimes difficult to observe in herbarium material.

- 6a. Cauline leaves free. Filaments usually not broadened at the base. Calyx venation reticulate. Bracts free or perfoliate, apex of bracts acute. Corolla mostly hexamerous **3. Duplipetala**
- b. Cauline leaves perfoliate. Filaments broadened at the base. Calyx venation not reticulate. Bracts perfoliate, orbiculate; apex of bracts obtuse. Corolla mostly pentamerous **6. Phyllocyclus**

Notes — The main axis of Canscorinae shows monopodial branching. Cymes are defined as flower-bearing branches of the first order.

Whether 2- or 3-lobed calyces (e.g. in *Microrphium*, *Cracosna*, *Duplipetala*) represent flower merosity or are the product of sepal-fusion still needs to be investigated.

1. CANSCORA Lam.

Canscora Lam. (1785) 601. — Type: *Canscora perfoliata* Lam.

Orthostemon R.Br. (1810) 451. — Type: *Orthostemon erectus* R.Br.

Pladera Sol. ex Roxb. (1820) 416 p.p. — Type: *Pladera sessiliflora* Roxb.

Heterocanscora C.B. Clarke (1875) 431. — Type: *Heterocanscora schultesii* (Wall. ex Griseb.) C.B. Clarke.

Annual, erect or rarely creeping, glabrous *herbs*; stems quadrangular, often strongly winged. Rosette *leaves* rarely present; cauline leaves free, sessile or rarely petiolate, lamina with one or three main veins. *Inflorescences* axillary cymes or rarely spikes; bracts free or perfoliate. *Flowers* tetramerous, sessile or rarely pedicellate, without bracteoles. *Calyx* tubular, sometimes strongly winged, mostly persistent or rarely disintegrating; lobes triangular to lanceolate. *Corolla* zygomorphic with two smaller and two larger lobes (Fig. 2c), salver- to funnelshaped, mostly white or pinkish purple; tube longer than lobes. *Androecium* anisomorphic (Fig. 2c), inserted in upper part of corolla tube; stamen between the two smaller corolla lobes inserted at higher level (upper stamen) than the remaining stamens (lower stamens), often with larger anther and longer filament which sometimes is broadened below the anther; anthers sagittate, persistent. *Ovary* oblong; stigmatic lobes oblong. *Fruit* an oblong capsule. *Seeds* irregular in shape, subglobose or angular, often cubical to rectangular and with shallowly sunken sides; outer testa reticulate, with shallow cells; testa cells irregularly polygonal, oriented irregularly; anticlinal walls prominent, mostly curved or straight; cuticle smooth.

Distribution — Nine species in tropical Asia, Africa and Australia.

KEY TO THE SPECIES OF CANSCORA

- 1a. Flowers arranged in a spike. Rosette leaves present **1.9. C. schultesii**
- b. Flowers arranged in lax cymes. Rosette leaves absent 2
- 2a. Filament of the upper stamen broadened below the anther 3
- b. Filaments of the upper stamen not broadened below the anther 6
- 3a. At least some bracts perfoliate. 4
- b. All bracts free 5
- 4a. Corolla 13–14 mm long. Calyx with wings up to 3.5 mm wide **1.7. C. perfoliata**
- b. Corolla 9–10 mm long. Calyx without wings **1.8. C. roxburghii**

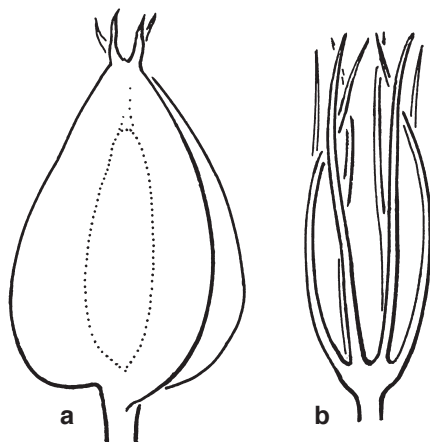


Fig. 1. a. Calyx of *Canscora macrocalyx* Miq.;
b. disintegrating calyx at fruit maturity of *C. andrographioides* Griff. ex C.B. Clarke.

- 5a. Calyx with wings up to 3.5 mm wide, wings largest in lower part of calyx (Fig. 1).
Few-flowered cymes **1.6. *C. macrocalyx***
b. Calyx with 1–1.3 mm wide wings, wings \pm equally wide along the calyx. Many-
flowered cymes **1.1. *C. alata***
6a. Calyx with wings 1–1.6 mm wide **1.3. *C. concanensis***
b. Calyx without wings 7
7a. Flowers sessile. Leaves < 15 mm long, ovate. Stems strongly winged.
..... **1.5. *C. heteroclita***
b. At least some flowers pedicellate. Leaves > 20 mm long, of various shape. Stems
 \pm unwinged 8
8a. Calyx > 10 mm long, 3.5–7 times longer than wide, sometimes disintegrating at
fruit maturity (Fig. 1). Corolla > 15 mm long. Anthers of different size. Flowers in
1–3-flowered axillary cymes. Leaves sometimes falcate
..... **1.2. *C. andrographioides***
b. Calyx < 7 mm long, 1.5–5 times longer than wide, persistent at fruit maturity. Co-
rolla < 14 mm long. Anthers \pm of equal size. Flowers in 3–many-flowered cymes.
Leaves never falcate **1.4. *C. diffusa***

Note — In contrast to *Cracosna* which mostly grows in dry habitats, *Canscora*, *Hoppea* and *Schinziella* prefer moist places. The occurrence of many taxa like *Canscora diffusa* and *C. alata* along rivers may indicate seed dispersal by water.

1.1. *Canscora alata* (Roth) Wall. — Plate 1g, h; Map 1, 2

Canscora alata (Roth) Wall. (1831) 4363. — *Exacum alatum* Roth (1818) 159. — Type: *Hildebrandt* 3303 (neo P, fide Klackenberg (1990); iso BM, K n.v.), Madagascar, Statio Nosi-Be, Dec. 1879.
Pladera decussata Roxb. (1820) 418. — *Canscora decussata* (Roxb.) Roem. & Schult. (1827) 229.
— Type: Roxburgh Ic. No. 236 (K n.v.).

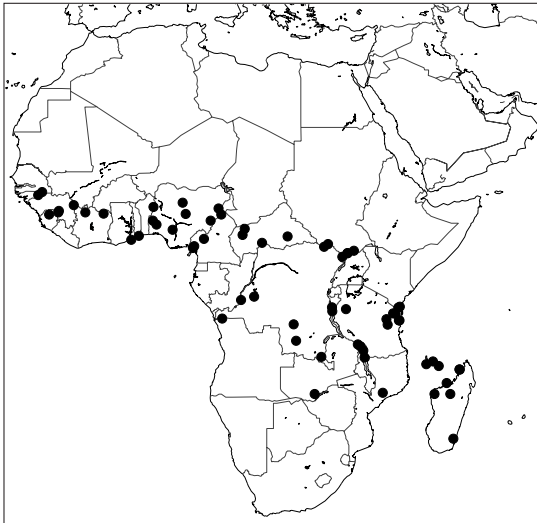
Plants 5–55 cm tall; stems basally and apically branched, with prominent wings up to 1.6 mm wide. Cauline leaves sessile, lamina with three main veins, elliptic to lanceolate, often falcate, 11–38 by 7–27 mm, base wedge-shaped to shortly attenuate, apex acute. *Inflorescences* axillary, 1–7-flowered cymes; bracts linear to lanceolate, 4.5–12

by 1–4 mm; pedicels 2–26 mm long. *Calyx* 11–14 by 2–3 mm, persistent, with eight prominent, 1–1.3 mm wide wings; tube 8–9 mm long; lobes anisomorphic, acute, two larger lobes 1.8 by 1.2 mm long, two shorter lobes 1.5 by 1.2 mm. *Corolla* tube 8–9 mm long, white, two lobes broadly elliptic, 4–4.5 by 2–2.5 mm, the other two lobes elliptic, 3 by 1.5 mm. Filament of upper *stamen* 1.8–2.2 mm long, broadened below anther, anther 0.8–0.9 by 0.6 mm; filaments of lower stamens 1.5–2 mm long, anthers 1–1.1 by 0.4–0.5 mm. *Ovary* 6–8 by 1.5–1.8 mm; style up to 4 mm long; stigmatic lobes 0.7 by 0.4 mm. *Capsule* 8 by 4 mm. *Seeds* irregular in shape, cubical to rectangular and with shallowly sunken sides, c. 0.38 by 0.21 mm; outer testa reticulate, with shallow cells; testa cells irregularly polygonal, oriented irregularly; anticlinal walls curved.

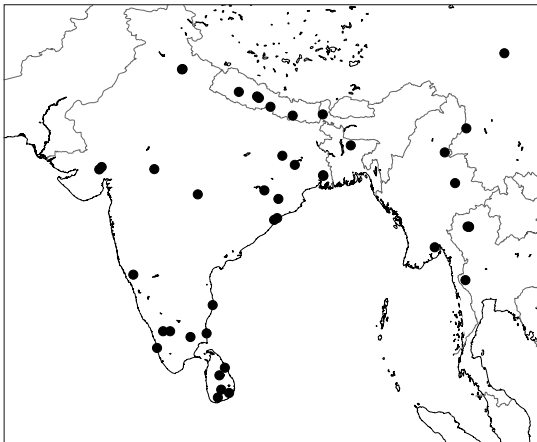
Distribution — Tropical Africa and S Asia.

Ecology — Shady, rocky river banks, grasslands, swamps, savannahs; sandy clayish soil. Sea level to 2500 m altitude. Flowering: throughout the year.

Chromosome number — $2n = 76$ (Mallikarjuna et al., 1989).



Map 1. Distribution of *Canscora alata* (Roth) Wall. in Africa.



Map 2. Distribution of *Canscora alata* (Roth) Wall. in Asia.

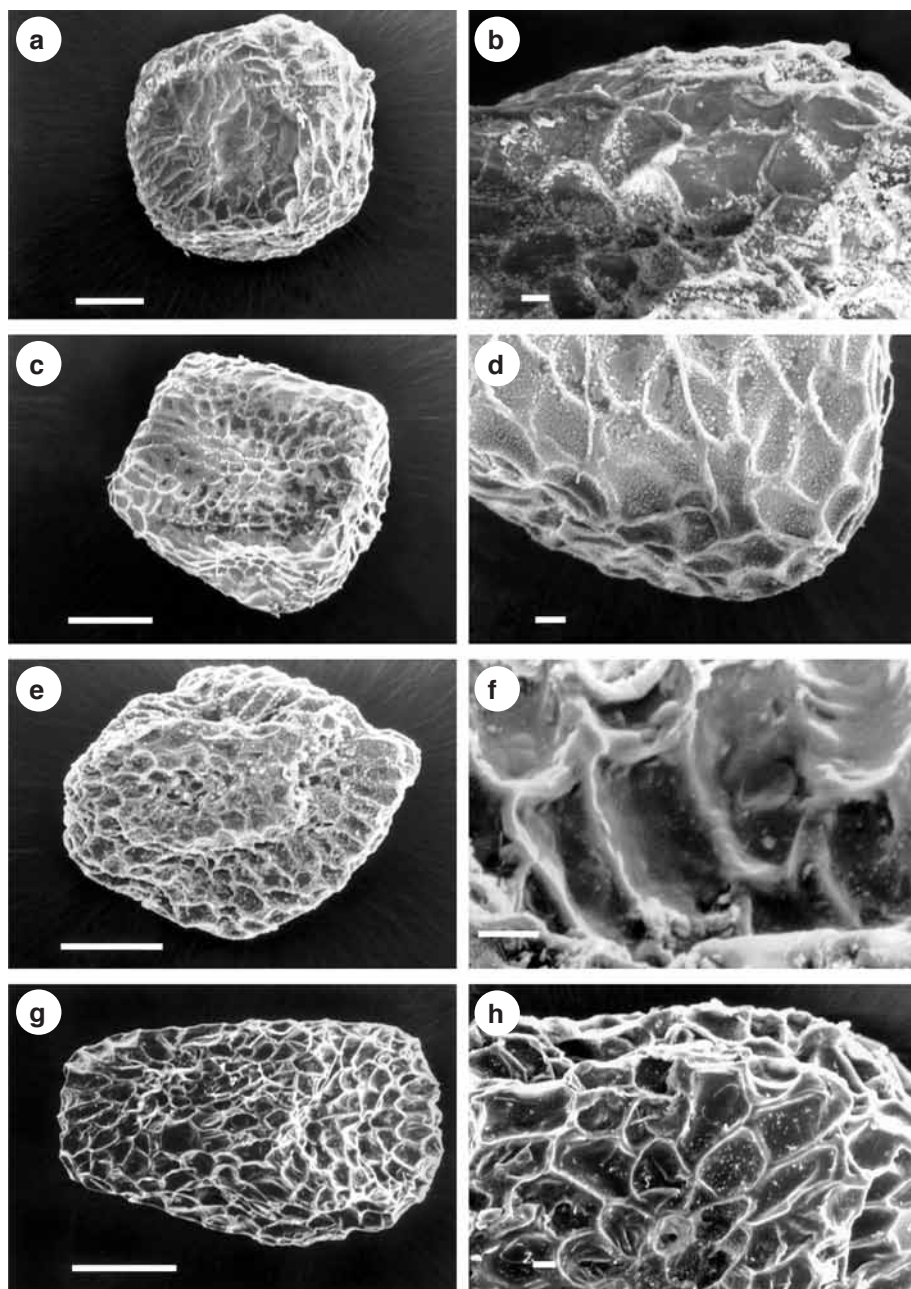


Plate 1. SEM photographs of seed coat structures. — a, b. *Canscora perfoliata* Lam. (Thompson s.n.); c, d. *C. roxburghii* Arn. ex Miq. (Cramer 4926); e, f. *C. macrocalyx* Miq. (Kooper s.n.); g, h. *C. alata* (Roth) Wall. (Wyld 324). — Scale bars: a, c, e, g = 100 μm; b, d, f, h = 10 μm.

1.2. *Canscora andrographioides* Griff. ex C.B. Clarke — Fig. 1; Plate 2a, b; Map 3

Canscora andrographioides Griff. ex C.B. Clarke (1875) 431. — Type: *Griffith 5816/1* (lecto K, designated here; iso A), Khasya.

Canscora trinervia Ridl. (1908) 316. — Type: *Ridley 5507* (lecto BM, designated here), Gunung Sakau, Pahang, 10 July 1905.

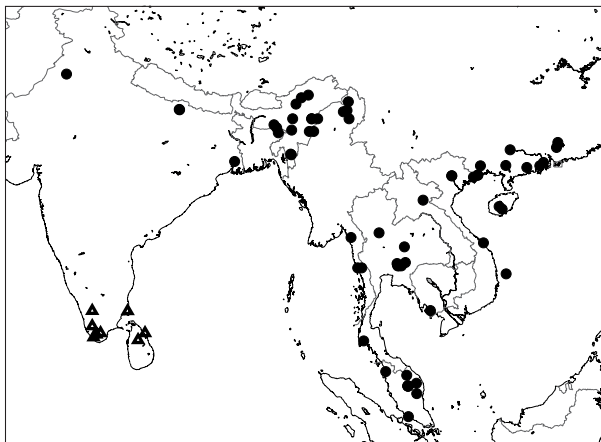
Canscora melastomacea Hand.-Mazz. (1932) 131. — Type: *Ching 7868* (lecto A, designated here; iso NY), China, Kwangsi, S Nanning, Seh-Feng, Dar Shan, 1200 ft, 15 Oct. 1928.

Plants erect to creeping, 6–80 cm tall; stems basally and apically branched, with minute ridges. *Cauline leaves* petiolate, petiole 1–13 mm long, lamina with three main veins, lanceolate to elliptic, often slightly falcate, 20–60 by 7–27 mm, base attenuate, apex acute. *Inflorescences* axillary, 1–3(–7)-flowered cymes; bracts linear to lanceolate, 2–20 by 0.5–7 mm; pedicels absent or up to 21 mm long. *Calyx* 11–14 by 2–3 mm, sometimes disintegrating (Fig. 1), with 8 ridges; tube 9–11 mm long; lobes beaked to taper-pointed, 1.8 by 0.4 mm. *Corolla* tube 11–16 mm long, white, two lobes broadly elliptic, 4.2–7.5 by 2.8–3.5 mm, the other two lobes elliptic, 3–4.5 by 1.8–3 mm. Filament of upper *stamen* 2–2.5 mm long, not broadened below anther, anther 1.3 by 1 mm; filaments of lower stamens 0.4–1.1 mm long, anthers 0.7–1 by 0.4–0.5 mm. *Ovary* 5–9 by 1–1.3 mm; style up to 9 mm long; stigmatic lobes 0.6 by 0.5 mm. *Capsule* 7–10 by 2–3.5 mm. *Seeds* irregular in shape, cubical to rectangular and with shallowly sunken sides, c. 0.50 by 0.38 mm; outer testa reticulate, with shallow cells; testa cells irregularly polygonal, oriented irregularly; anticlinal walls straight.

Distribution — Tropical S and SE Asia.

Ecology — Understorey of dipterocarp or evergreen forests, roadsides, grassland, swamps, rocky banks of streams; open clay grounds. From sea level to 2300 m altitude. *Flowering*: throughout the year.

Note — This species is extremely variable in habit and branching. No morphological characters were found which distinguish this species from *Canscora trinervia* which was described from West Malaysia and purported to have a smaller size and thinner leaves.



Map 3. Distribution of *Canscora andrographioides* Griff. ex C.B. Clarke (●) and *C. roxburghii* Arn. ex Miq. (▲).

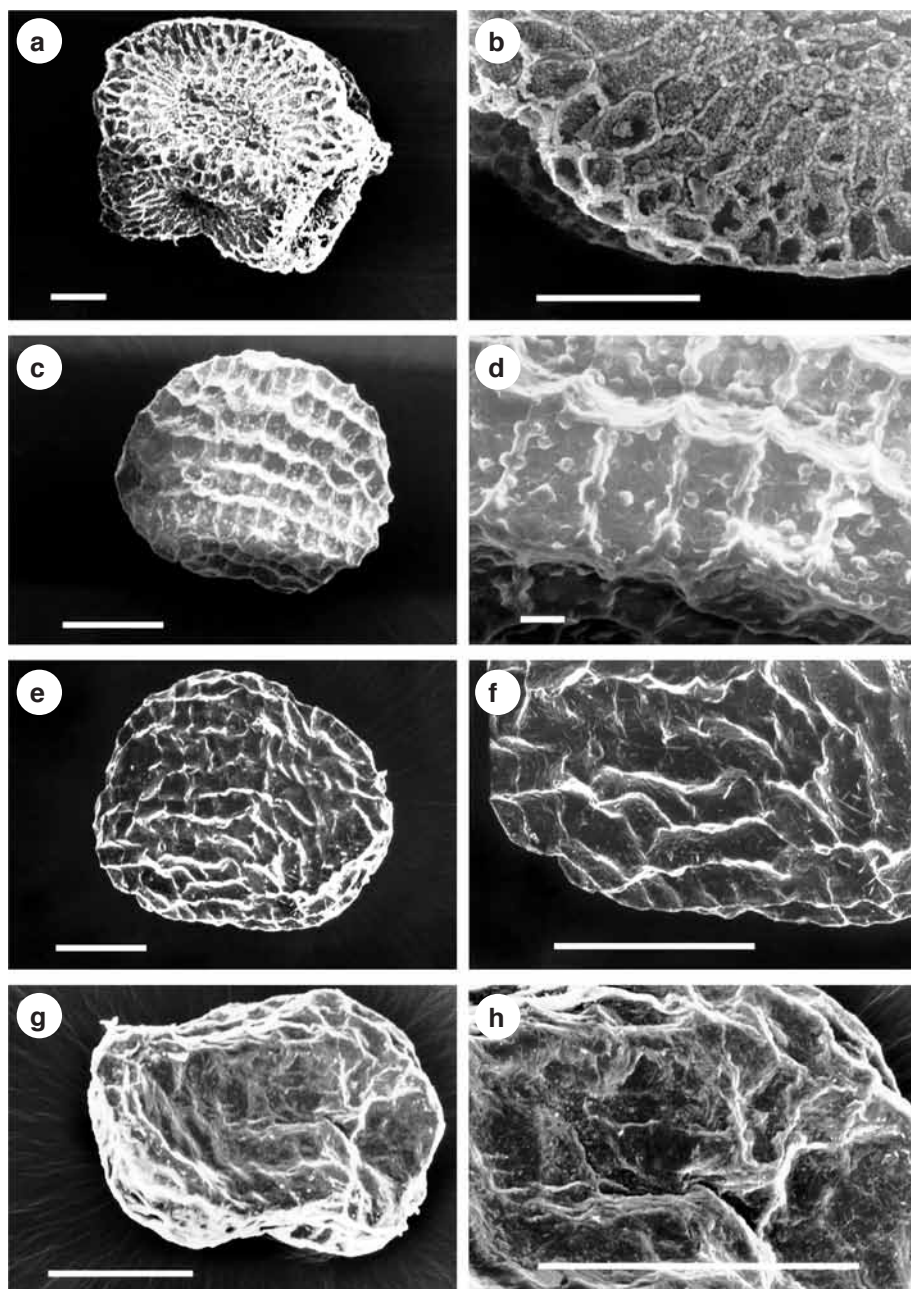


Plate 2. SEM photographs of seed coat structures. — a, b. *Canscora andrographioides* Griff. ex C.B. Clarke (Koelz 29638); c, d. *C. concanensis* C.B. Clarke (Radcliffe-Smith 5307); e, f. *C. diffusa* (Vahl) R.Br. ex Roem. & Schult. (Koyama 15568); g, h. *C. diffusa* (Koelz 4599). — Scale bars: a–c, e–h = 100 μm ; d = 10 μm .

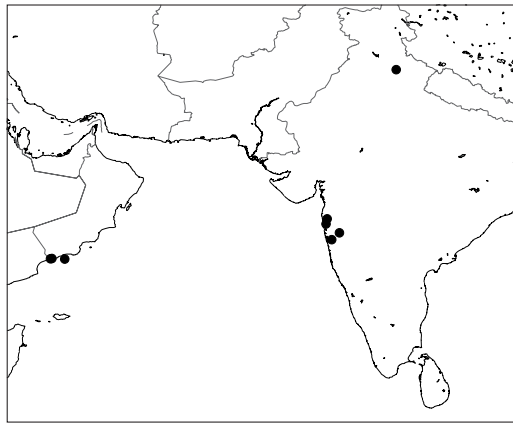
1.3. *Canscora concanensis* C.B. Clarke — Plate 2c, d; Map 4

Canscora concanensis C.B. Clarke (1885) 104. — Type: *Law s.n.* (holo K), India, Concoon.

Plants 8–26 cm tall; stems apically and partly basally branched, with minute ridges up to 0.1 mm wide. *Cauline leaves* sessile or rarely petiolate, petiole up to 6 mm long, lamina with one main vein, elliptic to lanceolate, 11–32 by 5–16 mm, base attenuate to shortly attenuate, apex acute. *Inflorescences* axillary, 1–6-flowered cymes; bracts linear to lanceolate, 1–6.8 by 0.2–2.6 mm; pedicels 3–15 mm long. *Calyx* 6–7.5 by 3–5 mm, persistent, with 4 prominent wings 1–1.6 mm wide; tube 5–6 mm long; lobes triangular, acute, 1 by 1.2 mm. *Corolla* tube 6–7 mm long, pink, two lobes broadly elliptic, 2.3–3 by 1.5–2 mm, the other two lobes elliptic, 1.3–1.5 by 0.7–0.8 mm. Filament of upper *stamen* 0.6–1 mm long, not broadened, anther 0.5–0.7 by 0.3–0.4 mm; filaments of lower stamens 0.7–1.1 mm long, anthers 0.6–0.8 by 0.3–0.4 mm. *Ovary* 3.5–5 by 1.2–1.3 mm; style 8–9 mm long; stigmatic lobes 0.4 by 0.3 mm. *Capsule* 4–5 by 1.5 mm. *Seeds* subglobose to angular, c. 0.28 by 0.25 mm; anticlinal walls straight; testa cells oriented in \pm linear rows.

Distribution — Oman, India.

Ecology — Open grasslands, roadsides or woodlands. Sea level to 700 m altitude. Flowering: September to November.



Map 4. Distribution of *Canscora concanensis* C.B. Clarke

1.4. *Canscora diffusa* (Vahl) R.Br. ex Roem. & Schult. — Plate 2e–h; Map 5, 6

Canscora diffusa (Vahl) R.Br. ex Roem. & Schult. (1818) 301. — *Gentiana diffusa* Vahl (1794) 47.

— *Exacum diffusum* (Vahl) Willd. (1798) 637. — Type: *Vahl s.n.* (holo C), India orientalis.

Orthostemon erectus R.Br. (1810) 451. — Type: *Banks & Solander 1770* (holo BM), New Holland, Endeavour River.

Canscora tenella Wall. (1831) 4362, nom. nud.

Canscora decurrens Dalzell (1850) 136. — Type: *Anonymous s.n.* (K).

Canscora pauciflora Dalzell (1850) 136. — Type: *Anonymous s.n.* (K).

Canscora lawii Wight (1850) 1327. — Type: *Ritchie 466* (lecto K, fide Klackenberg (1990); iso E), Belgium, Nord de Dharwur.

Canscora tenella Wight (1850) 1327. — Type: *Wight s.n.* (lecto K, fide Klackenberg (1990)), Malabar.

Canscora divaricata Miq. ex C.B. Clarke (1885) 103. — Type: *Hohenacker 670* (lecto TUB, designated here; iso E, G, K, MEL, S, U), India orientalis, prope Putore.

Canscora lancifolia Miq. ex C.B. Clarke (1885) 103. — Type: *Hohenacker 305* (lecto TUB, designated here; iso BM, E, G, HBG, K, L, S, U), India orientalis, prope Mangalore.

Canscora kirkii N.E. Br. (1903) 558. — Type: *Kirk s.n.* (holo K), Zambia, Island at Victoria Falls, 1860.

Canscora khandalensis Santapau (1949) 485. — Type: *Santapau 5015* (holo BLAT n.v.), Khandala, Bombay, 2 Oct. 1944.

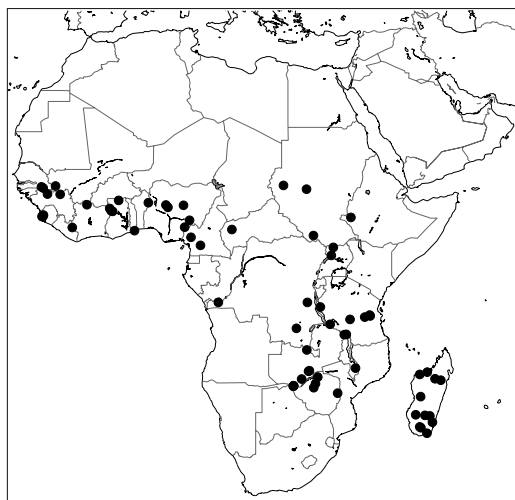
Canscora diffusa (Vahl) R.Br. ex Roem. & Schult. var. *tetraptera* Naik & Pokle (1985) 673. — Type: *Pokle 319* (n.v.), Aurangabad, Nagapur.

Canscora rubiflora X.X. Chen (1986) 177. — Type: *Ban 26597* (holo GXMI n.v.), Guangxi, Tianlin, Xian, Anding Xiang, 17 Feb. 1959.

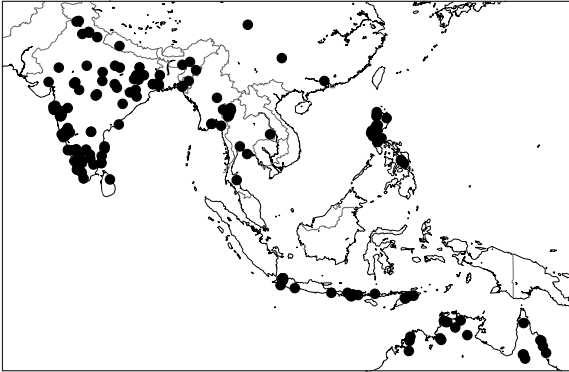
Plants 6–48 cm tall; stems basally and apically branched, with minute ridges up to 0.3 mm wide. Cauline *leaves* petiolate or rarely sessile, petiole up to 15 mm long, lamina with three main veins, elliptic, lanceolate to rarely ovate, 12–39 by 7–27 mm, base attenuate to wedge-shaped, apex acute; lower cauline leaves deciduous. *Inflorescences* axillary, 3–40-flowered cymes; bracts linear or lanceolate to broadly ovate, 1–4 by 0.1–1.2 mm; pedicels 1.5–15 mm long. *Calyx* 3.8–10 by 1–2.3 mm, persistent, without calyx wings; tube 2.9–6.5 mm long; lobes triangular, acute, 1–2.1 by 0.5–1.7 mm long. *Corolla* tube 4–7 mm long, pink, two lobes slightly larger than others, (broadly) elliptic, 1.4–5.6 by 0.8–3 mm, other two lobes elliptic 1.3–3.5 by 0.7–1.8 mm. Size of upper and lower *stamens* ± equal. Filaments 0.4–1.4 mm long, not broadened, anthers 0.3–1.1 by 0.3–0.4 mm. *Ovary* 2.8–6.5 by 0.5–2.8 mm; style 0.6–4.5 mm long; stigmatic lobes 0.3–0.7 by 0.2–0.5 mm. *Capsule* 3–7 by 1–3 mm. *Seeds* irregular in shape, cubical to rectangular and with shallowly sunken sides, 0.25–0.33 by 0.17–0.28 mm; outer testa reticulate, with shallow cells; testa cells irregularly polygonal, oriented in ± linear rows; anticlinal walls straight.

Distribution — Tropical Africa, Asia and Australia.

Ecology — Moist places of rocky river banks, grasslands, mixed deciduous forests, roadsides; sandy, clayish soil. Sea level to 2000 m altitude. Flowering: throughout the year.



Map 5. Distribution of *Canscora diffusa* (Vahl) R.Br. ex Roem. & Schult. in Africa.



Map 6. Distribution of *Canscora diffusa* (Vahl) R.Br. ex Roem. & Schult. in Asia and Australia.

Chromosome numbers — $2n = 36, 38$ (Christopher, 1976; Mallikarjuna et al., 1989).

Note — This species shows the widest distribution within the Canscorinae, ranging from tropical areas in Africa to Asia and Australia. It is also morphologically the most variable taxon of the subtribe. Several species (*C. decurrens*, *C. divaricata*, *C. lancifolia* and *C. pauciflora*) were described from India and are characterized by linear bracts and few-flowered inflorescences. Such individuals are found throughout the entire range of the species, sometimes even within collections with individuals with lanceolate to ovate leaves and many-flowered inflorescences. Consequently, these species are regarded as conspecific with *C. diffusa*. *Canscora khandalensis* from India was suggested to have larger flowers. This distinction, however, cannot be confirmed because the flower size range of *C. khandalensis* falls within that of *C. diffusa*. *Canscora kirkii*, an endemic from Southern Africa, was purported to differ from *C. diffusa* by having smaller flowers and many-flowered cymes. However, no clear boundary between these two taxa could be detected.

1.5. *Canscora heteroclita* (L.) Gilg — Plate 3a, b; Map 7

Canscora heteroclita (L.) Gilg (1895) 76. — *Gentiana heteroclita* L. (1767) 560. — *Exacum heteroclitum* (L.) Willd. (1798) 639. — Type: *Koenig s.n.* (holo LINN, Photo no. 328.43).

Pladera sessiliflora Roxb. (1820) 417. — *Canscora sessiliflora* (Roxb.) Roem. & Schult. (1827) 230. — Type: Roxburgh Ic. No. 1786 (K n.v.)

Plants 10–39 cm tall; stems basally and apically branched, with prominent wings up to 2.1 mm wide. Cauline *leaves* sessile, lamina with three main veins, ovate, 4–15 by 3.4–11 mm, base truncate to shortly attenuate, apex acute. *Inflorescences* axillary, 1–6-flowered cymes; bracts linear, slightly falcate, 1.5–4 by 0.2–0.6 mm. *Flowers* sessile. *Calyx* 8–9 by 1.5–1.6 mm, persistent, without calyx wings; tube 6–7 mm long; lobes acute, 2 by 1 mm. *Corolla* tube 6–9 mm long, rose, two lobes broadly elliptic, 3–5 by 2.2–4 mm, the other two lobes elliptic 1.2–2 by 2.7–3 mm. Filament of upper *stamen* 1.4–1.5 mm long, not broadened, anther 0.9–1.2 by 0.4–0.5 mm; filaments of lower stamens 1.1–1.9 mm long, anthers 1–1.4 by 0.4–0.5 mm. *Ovary* 4–4.3 by 1–1.1 mm; style up to 5.5 mm long; stigmatic lobes 0.8 by 0.7 mm. *Capsule* 5.5 by 1.5 mm. *Seeds* irregular in shape, cubical to rectangular and with shallowly sunken sides, c. 0.28 by

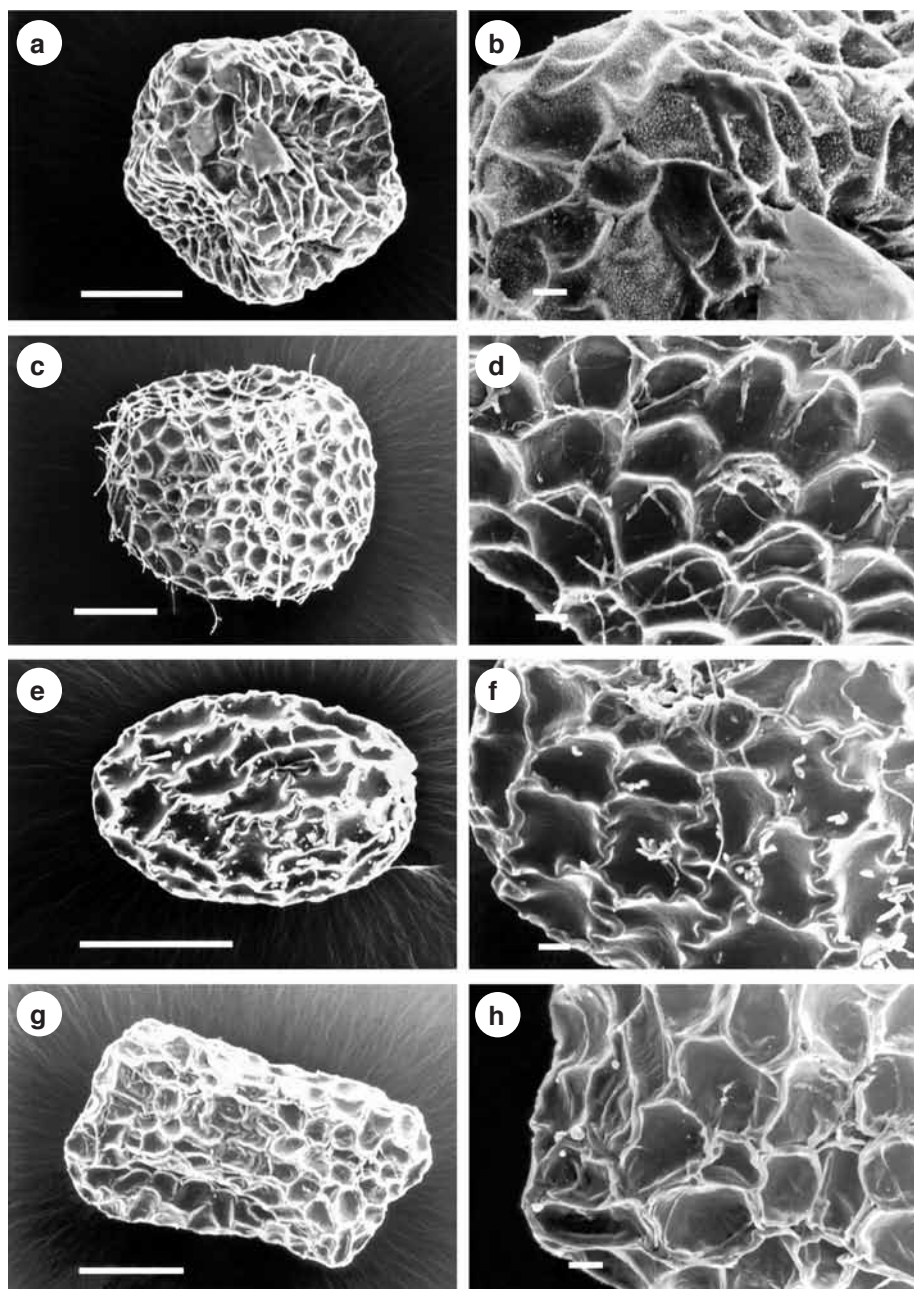
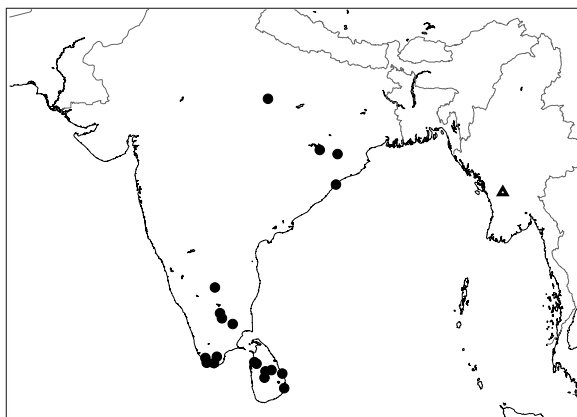


Plate 3. SEM photographs of seed coat structures. — a, b. *Canscora heteroclita* (L.) Gilg (*Cramer* 5129); c, d. *C. schultesii* Wall. ex Griseb. (*Kurz* 213); e, f. *Hoppea dichotoma* Willd. (*Wood RHT* 30759); g, h. *H. fastigiata* (Griseb.) C.B. Clarke (*Jayasuriya* 2092). — Scale bars: a, c, e, g = 100 μ m; b, d, f, h = 10 μ m.



Map 7. Distribution of *Canscora heteroclita* (L.) Gilg (●) and *C. schultesii* Wall. ex Griseb. (▲).

0.26 mm; outer testa reticulate, with shallow cells; testa cells irregularly polygonal, oriented irregularly; anticlinal walls straight.

Distribution — India and Sri Lanka.

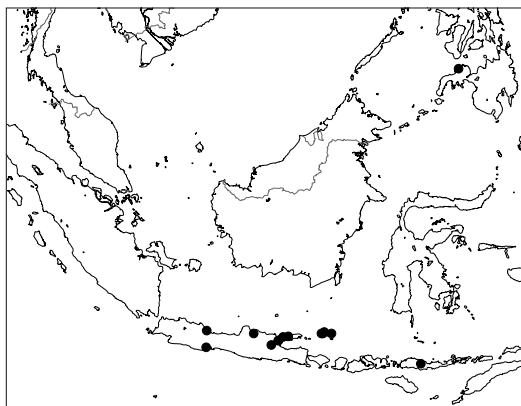
Ecology — Moist places of open waste- and grassland, along ponds and streams, roadsides; sandy, heavy, rocky ground. Sea level to 700 m altitude. Flowering: throughout the year.

Chromosome number — $2n = 38$ (Mallikarjuna et al., 1989).

1.6. *Canscora macrocalyx* Miq. — Fig. 1; Plate 1e, f; Map 8

Canscora macrocalyx Miq. (1856) 558. — Type: *Horsfield s.n.* (holo U), Java, Soerakarta.

Plants 8–39 cm tall; stems sparsely apically and partly basally branched, with prominent wings up to 1.5 mm wide. *Cauline leaves* sessile, lamina with three main veins, lanceolate, 5–18 by 3–9 mm, base shortly attenuate, apex acute. *Inflorescences* axillary 1–5-flowered cymes; bracts lanceolate, 5–9 by 2–4.5 mm; pedicels 3–13 mm long. *Calyx* tube 10–13 by 3–9 mm (incl. wings), persistent, with 4 prominent calyx



Map 8. Distribution of *Canscora macrocalyx* Miq.

wings 1–3.5 mm wide; tube 7.5–11 mm long; lobes blunt with a point, 1 by 0.5 mm. *Corolla* tube 9–11 mm long, white, two lobes broadly elliptic, 2–3 by 3–4.5 mm, the other two lobes elliptic 3 by 0.8–1.2 mm. Filament of upper *stamen* 1.7–1.9 mm long, broadened below anther, anther 0.8 by 0.4 mm; filaments of lower stamens 1.1–1.2 mm long, anthers 0.8–0.9 by 0.3–0.4 mm. *Ovary* 6–7 by 1.8–2.5 mm; style up to 4.5 mm long; stigmatic lobes 0.8 by 0.3 mm. *Capsule* 6–9 by 2.2 mm. *Seeds* irregular in shape, cubical to rectangular and with shallowly sunken sides, c. 0.35 by 0.26 mm; outer testa reticulate, with shallow cells; testa cells irregularly polygonal, oriented irregularly; anticlinal walls straight.

Distribution — Java and Timor. One specimen was found on Mindanao (Philippines).

Ecology — Moist, open places in grasslands, fields; heavy soil. Sea level to 600 m altitude. Flowering: January to August.

1.7. *Canscora perfoliata* Lam. — Plate 1a, b; Map 9

Canscora perfoliata Lam. (1785) 601. — Type: Rheede tot Draakestein, Hortus indicus malabaricus 10: 103, f. 52 (1690).

Canscora ventricosa J.F. Gmel. (1791) 262, nom. superfl.

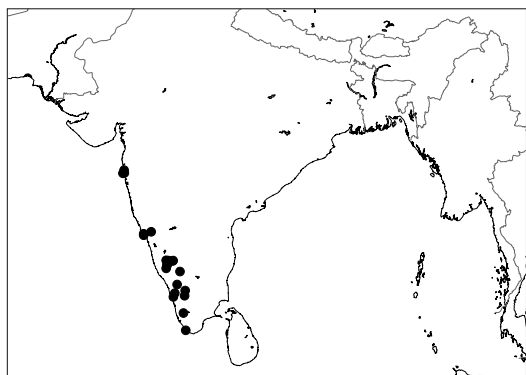
Canscora alata Wall. (1831) 4363, nom. nud.

Pladera alata Buch.-Ham. ex Wall. (1831) 4363B, nom. nud.

Canscora grandiflora Wight (1850) 1326. — Type: *Jerdon s.n.* (n.v.), Coorg and Western provinces of Mysore.

Canscora macrocalyx Miq. ex C.B. Clarke (1885) 104, nom. illeg., non Miq. (1855). — Type: *Hohenacker 810* (lecto TUB, designated here; iso BM, E, G, K, S), India orientalis, Terra Canara et confin. In campis prope Mercara.

Plants 18–69 cm tall; stems basally and apically branched, with prominent wings up to 2.5 mm wide. Cauline *leaves* sessile, lamina with three main veins, elliptic to lanceolate, often falcate, 10–58 by 5–39 mm, base attenuate, apex acute. *Inflorescences* axillary, 1–3-flowered cymes; bracts orbicular, perfoliate, apex blunt or acute, 5–14 by 5–15 mm; pedicels 1–10 mm long. *Calyx* 13–15 by 7–8 mm, persistent, with prominent four or eight wings 2–3.5 mm wide; tube 10–12 mm long; lobes anisomorphic, acute, two larger lobes 3 by 1 mm long, two shorter lobes 2 by 1 mm. *Corolla* tube 13–14 mm long, white or cream, two lobes broadly elliptic, 8–9 by 6–8 mm, the other two lobes



Map 9. Distribution of *Canscora perfoliata* Lam.

elliptic, 5–6 by 1.8–3 mm. Filament of upper stamen 2.5–2.8 mm long, broadened below the anther, anther 1–1.8 by 0.7–1 mm; filaments of lower stamens 0.6–1.5 mm long, anthers 1.6–2.1 by 0.5–0.7 mm. Ovary 6–8 by 1.8–2.5 mm; style up to 9 mm long; stigmatic lobes 0.9 by 0.8 mm. Capsule 7 by 2 mm. Seeds irregular in shape, cubical to rectangular and with shallowly sunken sides, c. 0.40 by 0.36 mm; outer testa reticulate, with shallow cells; testa cells irregularly polygonal, oriented irregularly; anticlinal walls straight.

Distribution — W India.

Ecology — Shady, wet places along roadsides and in deciduous forests. Altitude 400–1500 m. Flowering: October to March.

Chromosome number — $2n = 38$ (Mallikarjuna et al., 1989).

1.8. *Canscora roxburghii* Arn. ex Miq. — Fig. 2; Plate 1c, d; Map 3

Canscora roxburghii Arn. ex Miq. (1852) 11. — Type: Roxburgh Ic. No. 1227 (K).

Canscora wallichii C.B. Clarke (1885) 105. — Type: *Wallich 4365* (holo K-WALL, photo), Travancore.

Plants 6–54 cm tall; stems basally and apically branched, with prominent wings up to 1.4 mm wide. Cauline *leaves* sessile, lamina with three main veins, elliptic to lanceolate, slightly falcate, 10–38 by 4–16 mm, base attenuate, apex acute. *Inflorescences* axillary, 1–8-flowered cymes; bracts orbicular, perfoliate, 4–13 by 5–13 mm; pedicels 1–17 mm long. *Calyx* 8–9 by 1–2 mm, persistent, without wings; tube 7 mm long; lobes acute, 2 by 1 mm. *Corolla* tube 8–10 mm long, pale yellowish; two lobes broadly elliptic, 4.5–5 by 2.7–3.7 mm, the other two lobes elliptic 2.5–3 by 1.2–1.5 mm. Filament of upper *stamen* 1.7–1.9 mm long, broadened below anther, anther 0.7–0.9 by 0.4–0.5 mm; filaments of lower stamens 0.9–1.5 mm long, anthers 0.9–1.2 by 0.4–0.5 mm. *Ovary* 4–5 by 1–1.6 mm; style up to 3.5 mm long; stigmatic lobes 0.5 by 0.3 mm. *Capsule* 7 by 2.2 mm. *Seeds* irregular in shape, cubical to rectangular and with shallowly sunken sides, c. 0.32 by 0.27 mm; outer testa reticulate, with shallow cells; testa cells irregularly polygonal, oriented irregularly; anticlinal walls straight.

Distribution — S India and Sri Lanka.

Ecology — Damp roadside embankments among tall grass; gravelly loamy soil. Sea level to 2000 m altitude. Flowering: November to March.

Chromosome number — $2n = 38$ (Mallikarjuna et al., 1989).

1.9. *Canscora schultesii* Wall. ex Griseb. — Plate 3c, d; Map 7

Canscora schultesii Wall. ex Griseb. (1839) 155. — *Heterocanscora schultesii* (Wall. ex Griseb.)

C.B. Clarke (1875) 431. — Type: *Wallich 4368* (lecto K, designated here; iso BM, E, G), Prome Hills, 1832.

Pladera pulchella Wall. (1831) 4368, nom. nud.

Plants 7–22 cm tall; stems basally branched, with ridges up to 0.4 mm wide. Rosette *leaves* sessile, lamina with three main veins, elliptic, 10–26 by 5–14 mm, base wedge-shaped to attenuate, apex obtuse or acute; cauline leaves sessile, linear to long lanceolate, 2.5–6 by 0.4–0.6 mm, apex acuminate. *Inflorescences* 6–20-flowered spikes; bracts lanceolate, 9–11 by 1.4–2.5 mm. *Flowers* sessile. *Calyx* 6–6.8 by 0.8–1.2 mm, persistent, without calyx wings; tube 4.3–5.3 mm long; lobes taper-pointed, 1.2–1.8 by 0.5



Fig. 2. *Canscora roxburghii* Arn. ex Miq. a. Habit; b. calyx; c. corolla with stamens; d. stamens of anisomorphic androecium; e. gynoecium (all: Barnes 1835).

mm. *Corolla* tube 8–9 mm long, colour unknown, two lobes broadly elliptic, 2.3–2.4 by 1.4–1.8 mm, the other two lobes elliptic, 3.8–4 by 1.5–1.8 mm. Filament of upper *stamen* 1.4–1.7 mm long, not broadened, anther 1–1.1 by 0.5–0.7 mm; filaments of lower stamens 0.8–1 mm long, anthers 0.6–0.7 by 0.4–0.5 mm. *Ovary* 3.5–5 by 1.2–1.3 mm; style up to 3.5 mm long; stigmatic lobes 2.7–2.8 by 0.6–0.8 mm. *Capsule* 4.5 by 1.5 mm. *Seeds* subglobose, c. 0.32 by 0.28 mm; outer testa reticulate, testa cells polygonal; anticlinal walls curved.

Distribution — Burma.

Ecology — Unknown. Flowering: August.

Note — A rarely collected plant probably endemic to Burma.

DOUBTFUL OR EXCLUDED SPECIES

Canscora stricta Sedgw. (1921) 126. — Type: *Sedgwick & Bell 3393* (BLAT n.v.), Prov. Bombaiensis, North Canara, Castle Rock, 1600 m, Dec. 1917.

Plants up to 15 cm tall; stems sparsely branched, quadrangular. Cauline *leaves* sessile, lamina narrow lanceolate, 15 by 3 mm, apex acute; leaves deciduous. *Inflorescences* axillary, 3–40-flowered cymes; bracts linear or subulate. *Calyx* 7 by 1.5 mm without calyx wings; tube 5 mm long; lobes linear 2 mm long. *Corolla* 10 mm long, pink; two lobes larger than others, orbicular, other two lobes oblong. Filament of upper *stamen* de-curved apically, anthers 2 mm long. *Ovary* oblong. *Capsule* cylindrical 3 by 1.5 mm.

Distribution — NW India.

Ecology — On sheet rocks in forest clearings. Flowering: December.

Note — Unfortunately no specimens could be studied. The description of an anisomorphic androecium and a zygomorphic corolla indicates that *C. stricta* belongs to *Canscora*. Sedgwick's (1921) remark that also broadly ovate leaves occur, however, questions its taxonomic rank. Whether this taxon represents a good species or perhaps an atypic form of the morphologically variable *C. diffusa* can only be decided when sufficient material becomes available.

Canscora justicioides Griff. ex Voigt (1845) 520

Hitherto, no hints of the type collection could be found. Therefore, Griffith's collection 5807/1 (Z) representing *Exacum tetragonum* Roxb. has been chosen as neotype for the incomprehensively, but validly described *Canscora justicioides* Griff. ex Voigt.

2. CRACOSNA Gagnep.

Cracosna Gagnep. (1929) 776. — Type: *Cracosna xyridiformis* Gagnep.

Canscora Lam. (1785) 601 p.p.

Annual, erect, glabrous *herbs*; stems apically sparsely branched, quadrangular, winged or with ridges. Rosette *leaves* present or absent; cauline leaves free, sessile, lamina with one main vein. *Inflorescences* axillary, few or many-flowered cymes; bracts free. *Flowers* tetramerous (except calyx in *C. xyridiformis*); sessile or pedicellate; with or without bracteoles. *Calyx* tetramerous, di- or trimerous in *C. xyridiformis*, tubular, winged or not,

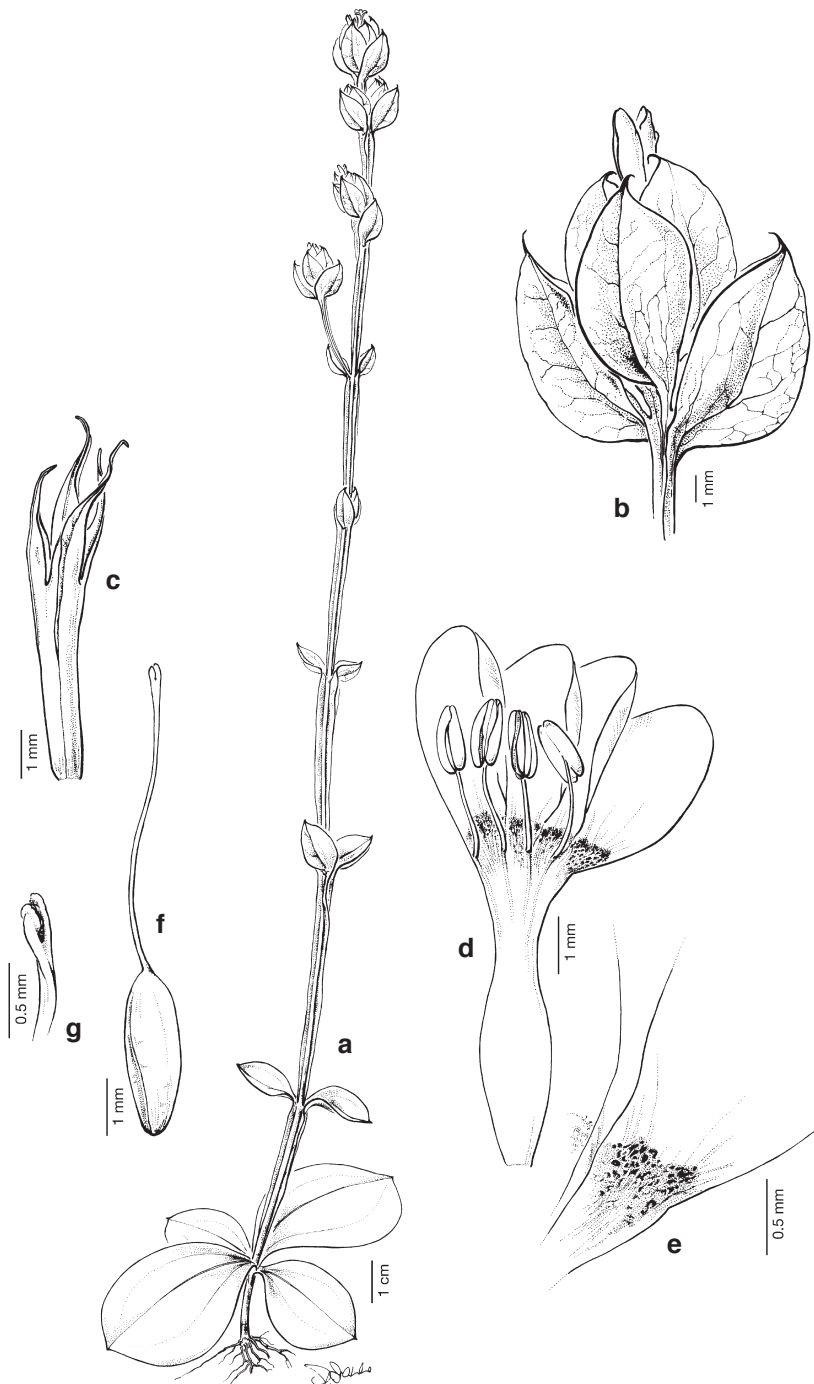


Fig. 3. *Cracosna carinata* (Dop) Thiv. a. Habit; b. flower; c. calyx; d. corolla with stamens; e. petal nectary; f. gynoeceium; g. stigma (all: *Chermsirivathana 1569*).

persistent. *Corolla* actinomorphic; salvershaped to tubular, mostly white or yellow, with nectaries between filaments; tube longer than lobes. *Androecium* isomorphic; inserted equally in upper part of corolla tube; anthers non-sagittate, persistent. *Ovary* oblong, ovoid or elliptic; stigmatic lobes oblong. *Fruit* an oblong capsule. *Seeds* irregular in shape, angular, often cubical to rectangular and with deeply sunken sides; outer testa reticulate, with shallow cells; testa cells polygonal, oriented irregularly; anticlinal walls prominent, mostly curved to straight; cuticle smooth.

Distribution — Three species in SE Asia.

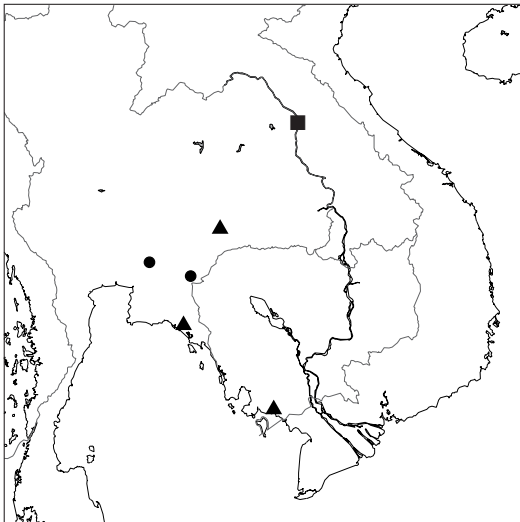
KEY TO THE SPECIES OF CRACOSNA

- 1a. Flowers in lax panicles. Calyx lobes 4 **2.2. *C. gracilis***
 b. Flowers in dense heads. Calyx lobes 2, 3 or 4. 2
 2a. Calyx lobes 2 or 3. Bracts broadly rhomboid, not carinate. Cauline leaves < 4 mm long, lanceolate **2.3. *C. xyridiformis***
 b. Calyx lobes 4. Bracts falcate, carinate. Cauline leaves > 4 mm long, broadly lanceolate **2.1. *C. carinata***

2.1. *Cracosna carinata* (Dop) Thiv, *comb. nov.* — Fig. 3; Plate 4c, d; Map 10

Canscora carinata Dop (1912) 145. — Type: *Massie s.n.* (holo P-photo).

Plants 10–43 cm tall; stems with ridges up to 3.5 mm wide. Rosette *leaves* sessile, lamina ovoid to elliptic to obovoid, 4–38 by 3–27 mm, base wedge-shaped to attenuate, apex obtuse; cauline leaves broadly lanceolate to triangular, 4.8–16 by 0.6–10 mm, apex acute to cuspidate. *Inflorescences* axillary, 1–7-flowered head-like cymes; bracts carinate, 5–10 by 2.1–6.2 mm, with wings up to 1.5 mm wide. *Flowers* sessile, without bracteoles. *Calyx* 5–7 by 1.2–1.5 mm, with wings up to 0.3 mm wide; tube



Map 10. Distribution of *Cracosna carinata* (Dop) Thiv (●), *C. gracilis* (Dop) Thiv (■) and *C. xyridiformis* (▲).

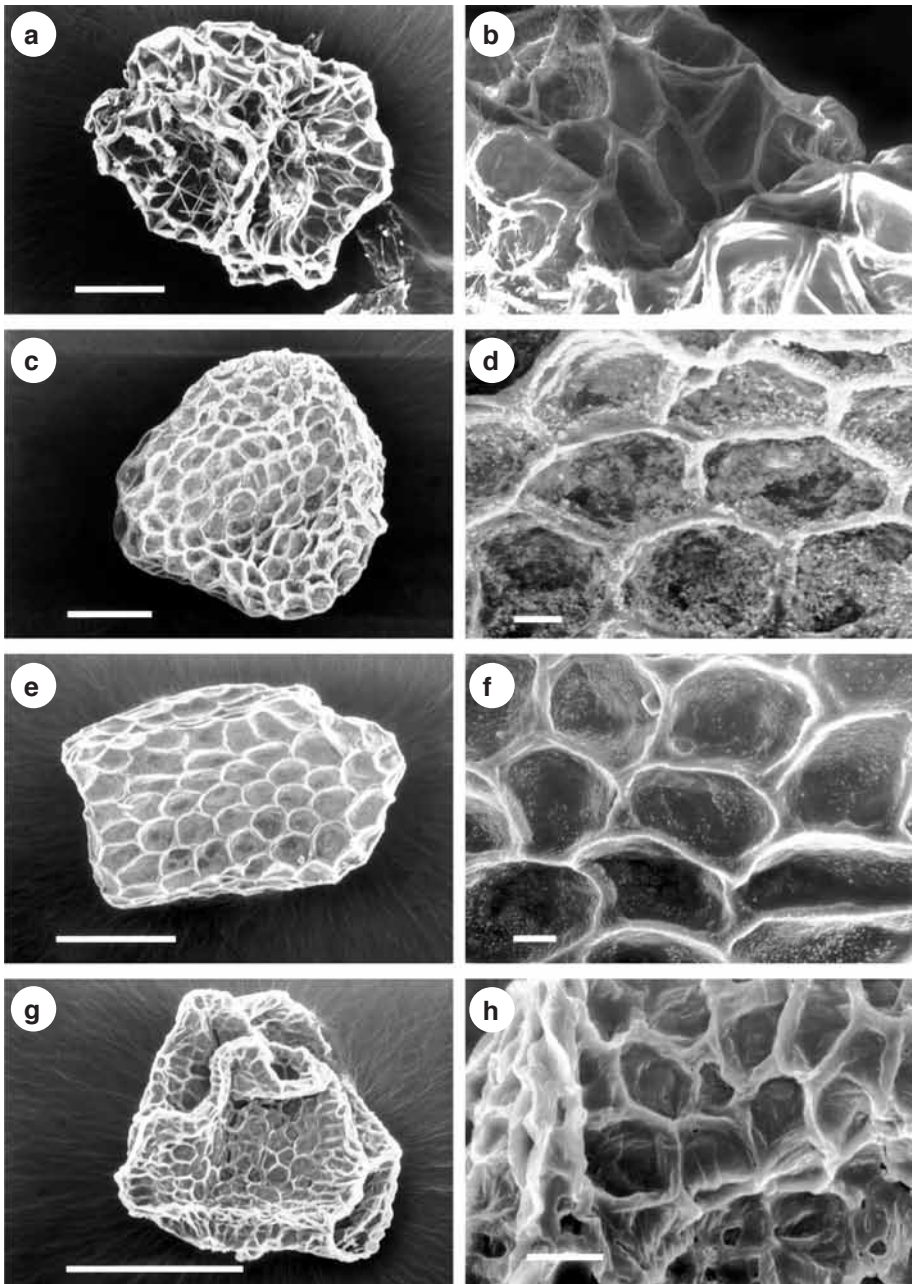


Plate 4. SEM photographs of seed coat structures. — a, b. *Schinziella tetragona* (Schinz) Gilg (*Champluvier 5136*); c, d. *Cracosna carinata* (Dop) Thiv (*Chermsirivathana 1569*); e, f. *C. gracilis* (Dop) Thiv (*Smitinand 8438*); g, h. *C. xyridiformis* Gagnep. (*Kerr 8226*). — Scale bars: a, c, e, g = 100 μm ; b, d, f, h = 10 μm .

2.8–3.8 mm long; lobes pungent, 2.2–3.3 by 0.6–0.8 mm. *Corolla* 8–9.5 mm long, white; lobes broadly lanceolate to oblong, 3.1–3.8 by 1–1.8 mm. *Filaments* 1.1–1.4 mm long; anthers 0.9–1.5 by 0.4–0.6 mm. *Ovary* oblong to long obovoid, 3.2–3.3 by 0.8–1 mm; style up to 4 mm long; stigmatic lobes oblong 0.4 by 0.2 mm. *Capsule* 3.5 by 1.7 mm. *Seeds* irregular in shape, with deeply sunken sides, c. 0.34 by 0.30 mm.

Distribution — Thailand and Laos (Dop, 1912).

Ecology — Dry soil. Flowering: October to November.

2.2. *Cracosna gracilis* (Dop) Thiv, *comb. nov.* — Plate 4e, f; Map 10

Canscora gracilis Dop (1912) 146. — Type: *Couillon s.n.* (holo P-photo).

Plants 10–25 cm tall; stems with ridges up to 0.6 mm wide. Rosette *leaves* sessile, lamina elliptic, 7–18 by 4–12 mm, base attenuate, apex obtuse to acute; cauline leaves lamina linear to long lanceolate, 2–4 by 0.4–0.7 mm, apex acute. *Inflorescences* 1–6-flowered panicle-like inflorescences; bracts linear, 2–2.5 by 0.2–0.3 mm. *Flowers* pedicellate, pedicels 2–4 mm long, with two linear bracteoles up to 2 mm long. *Calyx* 3.8–4.5 by 1–1.3 mm with four ridges; tube 2–2.4 mm long; lobes taper-pointed, 1.5–2 by 0.3–0.5 mm long. *Corolla* 5.5–7 mm long, colour unknown; lobes long elliptic to lanceolate, 1.8–2.5 by 4–5 mm. *Filaments* 0.8–1.3 mm long; anthers 0.3 by 0.2 mm. *Ovary* oblong, 3–4 by 0.7 mm; style up to 2 mm long; stigmatic lobes small oblong 0.2 by 0.1 mm. *Capsule* 3–4 by 1 mm. *Seeds* cubical to rectangular, c. 0.27 by 0.18 mm.

Distribution — Thailand and Laos.

Ecology — Dry dipterocarp forests. Altitude 200 m. Flowering: December.

Note — Due to their isomorphic androecia, *Canscora carinata* and *Canscora gracilis* were transferred to *Cracosna*.

2.3. *Cracosna xyridiformis* Gagnep. — Plate 4g, h; Map 10

Cracosna xyridiformis Gagnep. (1929) 776. — Type: *Geoffroy 461* (lecto P-photo, fide Hul (in press)), Cambodge, Kep, Province de Kampot, 28 Oct. 1904. Syntypes fide Hul (in press): *Massie s.n.* (P-photo), Laos; *Bois 2174* (n.v.); *Pierre s.n.* (n.v.).

Herb 18–45 cm tall; stems with minute 0.1 mm wide ridges. Rosette *leaves* probably absent or early deciduous; cauline leaves minute, lanceolate, 2–3.5 by 0.3–0.5 mm, apex acute. *Inflorescences* axillary, 3–30-flowered head-like cymes; bracts broadly rhomboid, 4.7–6 by 2.9–4.9 mm, without wings. *Flowers* (except calyx) tetramerous, sessile, without bracteoles. *Calyx* di- or trimerous, 4 by 1.5 mm, without calyx wings; tube 2–2.8 mm long; lobes obovoid, 1.2–2 by 0.8–1.1 mm, apex acute. *Corolla* 6–6.5 mm long, yellow; lobes broadly lanceolate, 2.2–2.5 by 1–2 mm. *Filaments* up to 1 mm long; anthers 0.7 by 0.3 mm. *Ovary* ovoid to elliptic, 3–3.2 by 1.1 mm; style bifid, up to 2.5 mm long; stigmatic lobes oblong 1.1 by 0.2 mm. *Capsule* 3.5 by 1.2 mm. *Seeds* irregular in shape, with deeply sunken sides, c. 0.16 by 0.14 mm.

Distribution — Thailand, Cambodia, Laos (Gagnepain, 1929).

Ecology — Open grassland in deciduous forests. Sea level to 100 m altitude. Flowering: September to January.

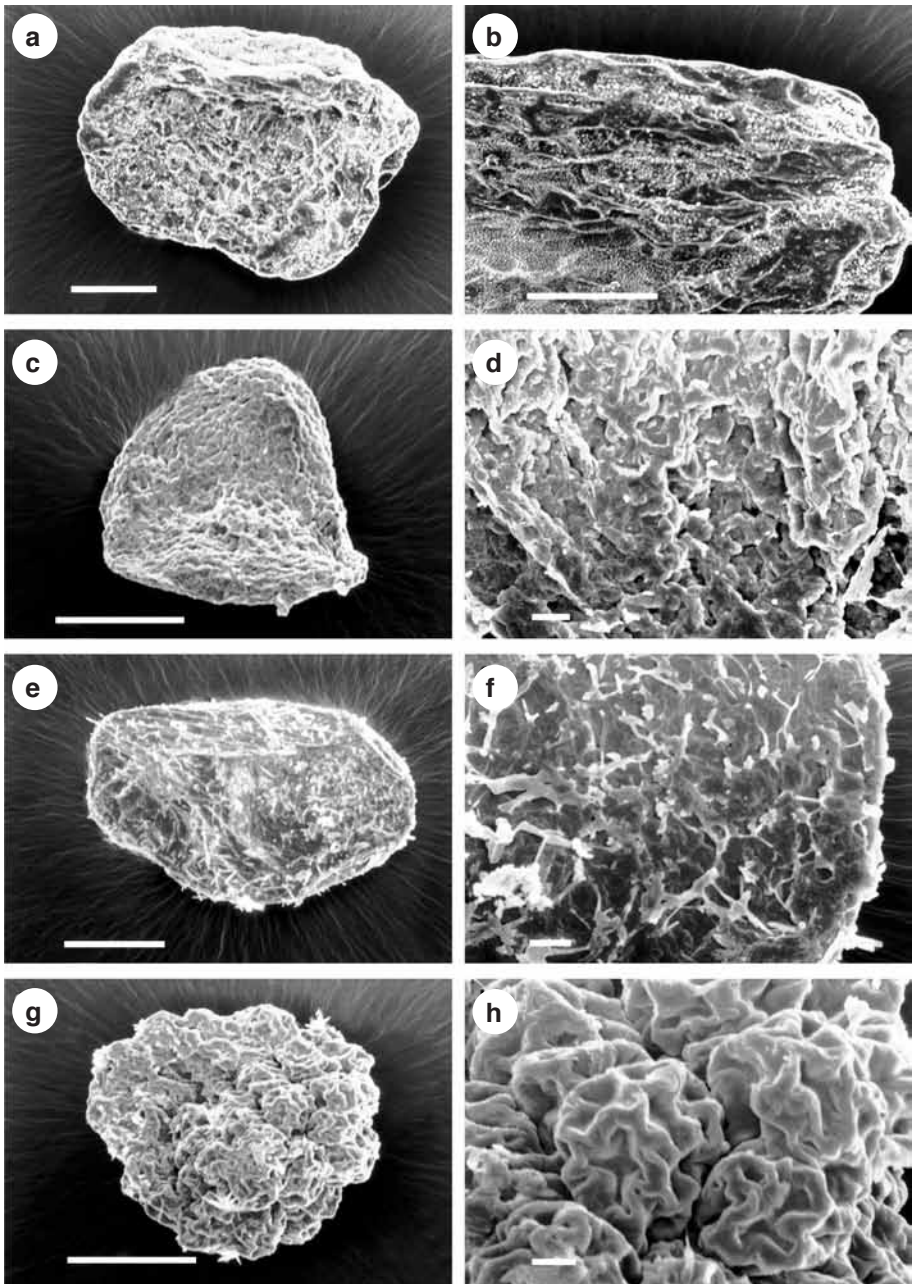


Plate 5. SEM photographs of seed coat structures. — a, b. *Microrhodium pubescens* C.B. Clarke subsp. *pubescens* (Hansen 12355); c, d. *Duplipetala pentanthera* (C.B. Clarke) Thiv (Meyer 9642); e, f. *D. hexagona* (Kerr) Thiv (Van Beusekom 3814); g, h. *Phyllocyclus helferianus* Kurz (Niyomdham 436). — Scale bars: a, c, e, g = 100 μ m; b, d, f, h = 10 μ m.

3. DUPLIPETALA Thiv, *gen. nov.*

Genus novus *Phyllocyclus* Kurz similis sed differt foliis caulinis libris, corolla hexamera et basi fili tenui. — Typus: *Duplipetala pentanthera* (C.B. Clarke) Thiv.

Canscora Lam. (1785) 601 p.p.

Perennial or annual, erect, glabrous *herbs*; stems apically and partly basally branched, terete sometimes with minute ridges. Rosette *leaves* absent; cauline leaves free, petiolate, lamina with one main vein, lanceolate to ovate, sometimes anisophyllous, base attenuate, apex acute. *Inflorescences* axillary, few-flowered, lax cymes; bracts perfoliate or free. *Flowers* hexa- or rarely pentamerous (except calyx); pedicellate; without bracteoles. *Calyx* tri- or hexamerous, inflated urceolate with reticulate venation, with unconnected wings, persistent; lobes triangular, apex acute to blunt with a point. *Corolla* actinomorphic, tubular to salvershaped, white-cream-coloured; tube longer than lobes; lobes broadly lanceolate, apex obtuse to cuspidate. *Androecium* isomorphic or anisomorphic with filaments of different length; inserted almost equally in central part of corolla tube; anthers sagittate, deciduous. *Ovary* oblong to obovoid, surface lacunose; stigmatic lobes rounded. *Fruit* an oblong capsule. *Seeds* irregular in shape, subglobose to angular with shallowly to deeply sunken sides; testa cells irregular in shape, oriented irregularly; cuticle with scurfy exudates.

Distribution — Two species in SE Asia.

Etymology — The name refers to the occurrence of six petals and three sepals in *D. pentanthera*.

Note — With its isomorphic or anisomorphic androecium with filaments of different length, *Duplipetala* is clearly distinct from *Canscora* s.str. It can be distinguished from *Phyllocyclus* by its free cauline leaves, mostly hexamerous corolla, a reticulate calyx venation and usually unbroadened filaments.

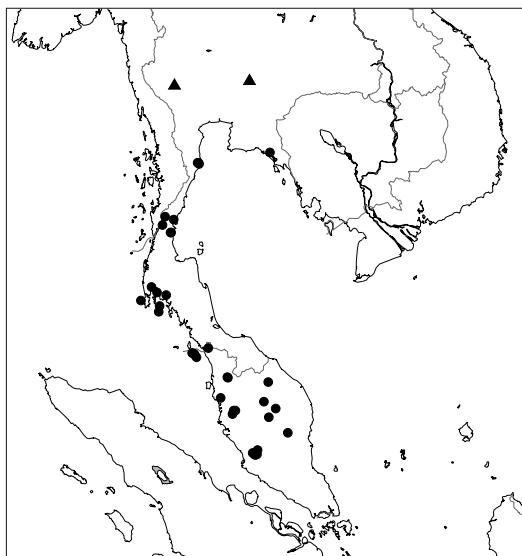
KEY TO THE SPECIES OF DUPLIPETALA

- 1a. Calyx lobes three. Plants perennial. Bracts mostly perfoliate **3.2. *D. pentanthera***
 b. Calyx lobes six. Plants annual. Bracts mostly free **3.1. *D. hexagona***

3.1. *Duplipetala hexagona* (Kerr) Thiv, *comb. nov.* — Plate 5e, f; Map 11

Canscora hexagona Kerr (1940) 181. — Type: *Kerr 8059* (lecto BM, designated here; iso E, K, L), Chan Tuk, Korat, 300 m, 18 Dec. 1923.

Annual *herbs* 12–47 cm tall; stems with minute ridges up to 0.2 mm wide. Cauline *leaves* slightly petiolate; petiole up to 0.5 mm long; lamina 13–70 by 5–31 mm. *Inflorescences* axillary, 3–8-flowered cymes; bracts lanceolate to linear, free, 1.7–5 by 0.7–2.1 mm. *Flowers* hexamerous; pedicels up to 3 mm long. *Calyx* urceolate 6.5–8 by 5–7.8 mm, with six wings up to 1 mm wide; tube 5.5–6.5 mm long; lobes 1.3–1.6 by 1.1–2 mm, with glands on its lower parts. *Corolla* tubular, 7–7.5 mm long; lobes 1.8–2 by 0.9–1.2 mm. *Stamens* mostly inserted at equal levels, filaments sometimes of different length, 2.5–3.8 mm long, anthers 0.7–0.9 by 0.5–0.6 mm. *Ovary* oblong to obovoid, surface constricted, 2.8–3.3 by 1.7–2 mm; style up to 4.3 mm long; stigmatic lobes 0.4 by 0.4 mm. *Capsule* 4.5 by 2.5 mm. *Seeds* c. 0.27 by 0.20 mm.



Map 11. Distribution of *Duplipetala hexagona* (Kerr) Thiv (▲) and *D. pentanthera* (C.B. Clarke) Thiv (●).

Distribution — Thailand.

Ecology — Open, fire influenced, dry dipterocarp forests, savannahs; limestone rocks. Altitude 400–1300 m. Flowering: November to December.

Note — Based on its free cauline leaves and its flower morphology, *Canscora hexagona* was transferred to *Duplipetala*.

3.2. *Duplipetala pentanthera* (C.B. Clarke) Thiv, *comb. nov.* — Fig. 4; Plate 5c, d; Map 11

Canscora pentanthera C.B. Clarke (1906) 89. — Type: *Ridley 8214* (holo K), Selangor, Gua Batu, limestone rocks, 1897.

Perennial, suffrutescent *herbs* 24–52 cm tall. *Cauline leaves* petiolate; petiole 9–44 mm long; lamina 38–95 by 16–36 mm. *Inflorescences* axillary, 2–20-flowered cymes; bracts broadly ovate, mostly perfoliate, 5–13 by 5–12 mm. *Flowers* (except calyx) hexa-, rarely pentamerous, pedicels up to 2 mm long. *Calyx* trimerous, 10–12 by 4–8 mm, with three wings up to 1.5 mm wide; tube 7–9 mm long; lobes 2.1–2.2 by 2.5–4 mm. *Corolla* salvershaped to tubular, 11.8–14 mm long; lobes 3–3.2 by 1.7–1.8 mm. *Filaments* sometimes of different length, 2–5 mm long; anthers 1.8–2 by 0.8–1 mm. *Ovary* oblong, surface constricted, 3.8–5 by 1.1–1.6 mm; style up to 7 mm long; stigmatic lobes 0.3 by 0.4 mm. *Capsule* 6 by 3 mm. *Seeds* c. 0.21 by 0.19 mm.

Distribution — Thailand and W Malaysia.

Ecology — Tropical forests, limestone rocks. Sea level to 1300 m altitude. Flowering: throughout the year.



Fig. 4. *Duplipetala pentanthera* (C.B. Clarke) Thiv. a. Habit; b. flower; c. calyx; d. corolla with stamens; e. gynoecium (all: Meyer 9642).

4. HOPPEA Willd.

Hoppea Willd. (1801) 434. — Type: *Hoppea dichotoma* Willd.

Pladera Sol. ex Roxb. (1820) 416 p.p.

Annual, erect, glabrous *herbs*; stems quadrangular, strongly winged. Rosette *leaves* absent; cauline leaves free, sessile; lamina with one main vein, base shortly attenuate to wedge-shaped, apex obtuse or cuspidate. *Inflorescences* axillary, many-flowered dense or lax cymes; bracts free. *Flowers* tetramerous, sessile or pedicellate, without bracteoles. *Calyx* funnelshaped to campanulate, with two ridges at the margin of each sepal, persistent; lobes triangular to blunt with a point. *Corolla* actinomorphic, tubular to funnelshaped, white; tube longer than lobes; lobes broadly elliptic. *Androecium* anisomorphic (Fig. 5c), stamens inserted in upper or lower part of corolla tube; one or rarely two upper stamens with longer filament and larger anther than the remaining lower stamens; anthers sagittate, persistent. *Ovary* obovoid to oblong elliptic; stigmatic lobes rounded to oblong. *Fruit* an obovoid to oblong elliptic capsule. *Seeds* elliptic to cubical to rectangular; outer testa reticulate, with shallow cells; testa cells irregularly polygonal, oriented irregularly; anticlinal walls prominent, mostly curved or undulating; cuticle smooth.

Distribution — Two species mainly on the Indian subcontinent.

KEY TO THE SPECIES OF HOPPEA

- 1a. Stamens inserted in the middle of the corolla tube. At least some flowers pedicellate. Stems basally and apically branched. Cauline leaves ovate **4.1. *H. dichotoma***
- b. Stamens inserted in the upper part of the corolla tube close to the sinuses. Flowers sessile. Stems mostly only apically branched. Cauline leaves ovate to rhomboid **4.2. *H. fastigiata***

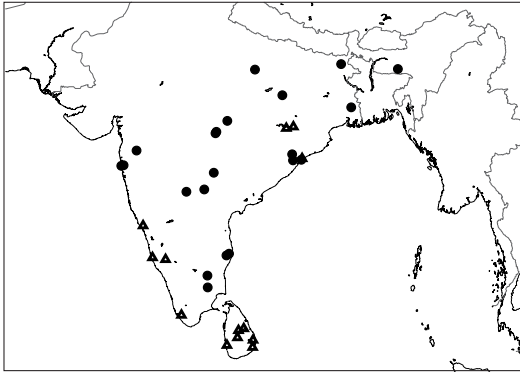
4.1. *Hoppea dichotoma* Willd. — Plate 3e, f; Map 12

Hoppea dichotoma Willd. (1801) 434. — Type: *Klein s.n.* (holo B-W), India orientalis, 1800.

Pladera pusilla Roxb. (1814) 10. — Type: *Wallich 4366* (holo K-WALL, photo).

Hoppea dichotoma Willd. forma *pedicellata* S.R. Paul (1977) 183. — Type: *Paul 96213A* (n.v.), Sadni, Netarhat, 28 Dec. 1972.

Plants 1.5–10 cm tall; stems basally and apically branched, with wings up to 0.5 mm wide. Cauline *leaves* ovate, 2.3–7 by 1.2–4 mm, base shortly attenuate, apex obtuse to cuspidate. *Inflorescences* axillary, 6–30-flowered lax dichasia; bracts linear to long-lanceolate, 1.8–5 by 0.3–1.6 mm. *Flowers* pedicellate or sessile, pedicels up to 3(–7) mm long. *Calyx* funnelshaped to campanulate, 2.3–3.1 by 1.3–2 mm; tube 1.4–2 mm long; lobes 1.1–1.6 by 0.6–1 mm. *Corolla* tube 2.5–3 mm long; lobes 1–1.4 by 0.5–0.7 mm. *Stamens* inserted in the middle part of the corolla tube; filament of upper stamen 0.4–0.5 mm long, anther 0.2–0.3 by 0.2 mm; filaments of the lower stamens 0.1–0.3 mm long, anthers 0.1 by 0.1 mm. *Ovary* 0.8–1.1 by 0.5–0.9 mm; style up to 0.2 mm long; stigmatic lobes oblong, c. 0.1 by 0.1 mm. *Capsule* 1.5 by 1.3 mm. *Seeds* elliptic, c. 0.21 by 0.14 mm; anticlinal walls undulating.



Map 12. Distribution of *Hoppea dichotoma* Willd. (●) and *H. fastigiata* (Griseb.) C.B. Clarke (▲). Occurrences of *H. dichotoma* in Africa and the Philippines are not shown.

Distribution — India. Probably introduced in the Philippines (Luzon), Senegal (Berhaut, 1975) and Ethiopia (Raynal, 1967).

Ecology — Open places of cultivated fields, roadsides and forests; 300–1800 m altitude. Flowering: October to March.

Notes — There are several arguments to regard the occurrence of *H. dichotoma* in Africa and the Philippines as not autochthonic: 1. Its sister species, *H. fastigiata* (Thiv & Kadereit, 2002) is restricted to India and Sri Lanka; 2. outside of India there were only a few specimens collected; 3. *Hoppea* grows as a weed in India, indicative of their potential for introduction; 4. the populations outside of India are very isolated.

The structure of vascular bundles of this species was studied by Kshetrapal (1973).

Chromosome number — $2n = 38$ (Mallikarjuna et al., 1989).

4.2. *Hoppea fastigiata* (Griseb.) C.B. Clarke — Fig. 5; Plate 3g, h; Map 12

Hoppea fastigiata (Griseb.) C.B. Clarke (1885) 100. — *Cicendia fastigiata* Griseb. (1839) 158. — *Pladera fastigiata* (Griseb.) C.B. Clarke (1875) 429. — Type: *Macrae s.n.* (lecto K, designated here), Ceylon, Colombo, in fields.

Plants 1–12 cm tall; stems mostly apically branched, with wings up to 1 mm wide. *Cauline leaves* ovate to rhomboid, 3.2–11 by 1.8–7 mm, base wedge-shaped to attenuate, apex obtuse to cuspidate. *Inflorescences* axillary, 3–20-flowered dense cymes; bracts linear to long lanceolate, 2.5–4.5 by 0.7–1.8 mm. *Flowers* sessile. *Calyx* long funnelshaped, 2.5–3.8 by 1.4–1.9 mm; tube 1.5–2 mm long; lobes 1.3–1.6 by 0.8 mm. *Corolla* tube 2–2.3 mm long; lobes 1–1.4 by 0.5–0.7 mm. *Stamens* inserted in the upper part of the corolla tube; filament of upper stamen 0.3–0.4 mm long, anther 0.3–0.4 by 0.3–0.5 mm; filaments of lower stamens 0.1–0.2 mm long, anthers 0.2–0.3 by 0.1–0.2 mm. *Ovary* 1.2–2.2 by 0.7–1.3 mm; style up to 0.8 mm long; stigmatic lobes oblong, 0.3 by 0.2 mm. *Capsule* 2.5 by 1.3 mm. *Seeds* cubical to rectangular, c. 0.35 by 0.19 mm; anticlinal walls curved.

Distribution — India and Sri Lanka.

Ecology — Moist patches of grasslands and secondary forests. Sea level to 1700 m altitude. Flowering: throughout the year.

Chromosome number — $2n = 38$ (Mallikarjuna et al., 1989).

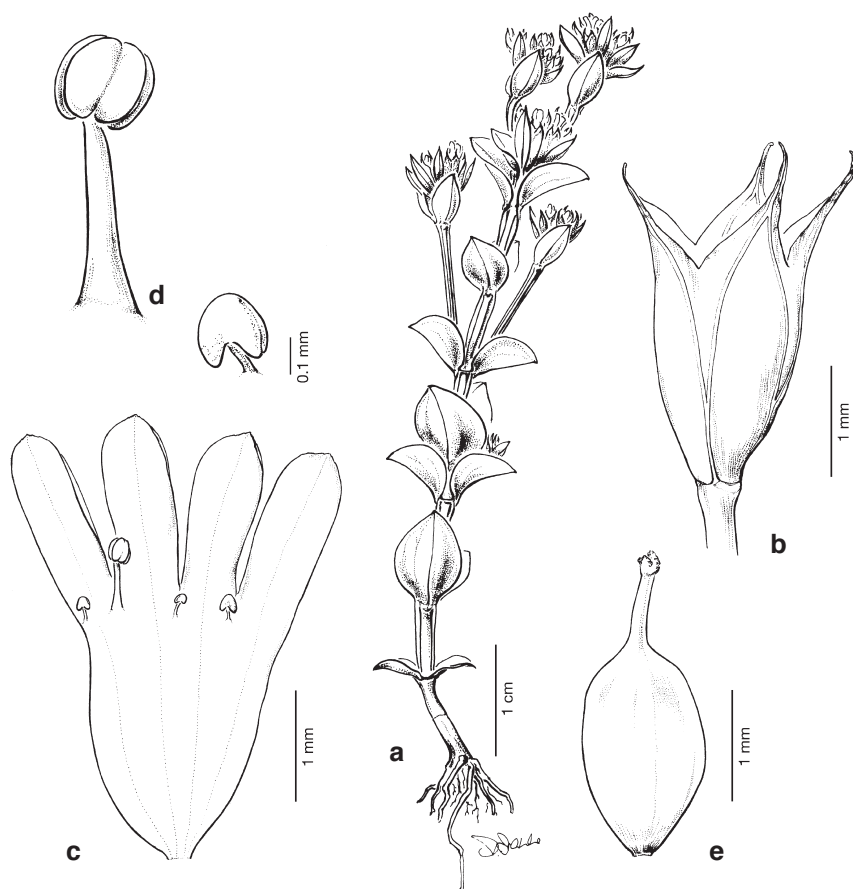


Fig. 5. *Hoppea fastigiata* (Griseb.) C.B. Clarke. a. Habit; b. calyx; c. corolla with stamens; d. stamens of anisomorphic androecium; e. gynoeceum (all: *Cramer 5143*).

5. MICRORPHIUM C.B. Clarke

Microphium C.B. Clarke (1906) 88. — Type: *Microphium pubescens* C.B. Clarke.

Perennial, erect, suffrutescent *herbs* with bristles on all green parts; stems mostly apically branched, terete without ridges. Rosette *leaves* absent; cauline leaves free, petiolate; lamina with one main vein, lanceolate to ovate, base attenuate to wedge-shaped, apex acute. *Inflorescences* axillary, many-flowered, lax monochasia; bracts free. *Flowers* pentamerous (except calyx), pedicellate, without bracteoles. *Calyx* dimerous, tubular, without wings, persistent; two triangular lobes, apex acute to blunt with a point. *Corolla* actinomorphic, salvershaped, white-cream-coloured; tube longer than lobes. *Androecium* isomorphic; stamens inserted equally in upper part of corolla tube; anthers sagittate, deciduous. *Ovary* obovoid; stigmatic lobes minute. *Fruit* an obovoid to oblong capsule. *Seeds* irregular in shape, subglobose to angular with shallowly sunken sides;

outer testa irregular in shape, with shallow cells; testa cells irregular in shape, oriented irregularly; anticlinal walls straight; cuticle with scaly exudates.

Distribution — One species in SE Asia.

5.1. *Microrhodium pubescens* C.B. Clarke

Microrhodium pubescens C.B. Clarke (1906) 88. — Type: *Curtis* 2528 (K n.v.), Kedah.

Microrhodium elmerianum Regalado & Soejarto (1997) 77. — Type: *Soejarto et al.* 6499 (holo F; iso A n.v., PHN n.v.), Philippines, Palawan Island, Puerto Princesa, Bacungan hills, slopes above Nagtabon beach, 9° 51' N, 118° 37' E, 50–100 m, 9 April 1989.

Plants 35–150 cm tall. *Cauline leaves* petiolate; petiole 2–48 mm long; lamina 30–140 by 14–46 mm. *Inflorescences* axillary, 12–30-flowered, ± erect or pendulous lax monochasia; bracts broadly obovoid to elliptic, 3–9.7 by 1.7–4 mm; pedicels 2–12 mm long. *Calyx* 4–4.5 by 1.9–2.1 mm; tube 3–3.2 mm long; lobes 1–1.3 by 2 mm. *Corolla* 4.8–5.2 mm long; lobes elliptic, 2.2–3.2 by 0.9–1 mm, apex obtuse to cuspidate. *Filaments* 0.2–1.8 mm long; anthers 1.9–2.2 by 0.5–0.6 mm. *Ovary* 1.9–2.2 by 1.1–1.3 mm; style up to 3.3 mm long; stigmatic lobes 0.2 by 0.1 mm. *Capsule* 4 by 2.5 mm. *Seeds* 0.35–0.4 by 0.27 mm.

Ecology — Tropical forests; limestone rocks. Sea level to 260 m altitude.

KEY TO THE SUBSPECIES OF MICRORPHIUM PUBESCENS

- 1a. Inflorescence more or less erect. Petiole 2–48 mm long. — Peninsular Malaysia
 **a. subsp. pubescens**
 b. Inflorescence more or less pendulous. Petiole 3–20 mm long. — Palawan Island
 **b. subsp. elmerianum**

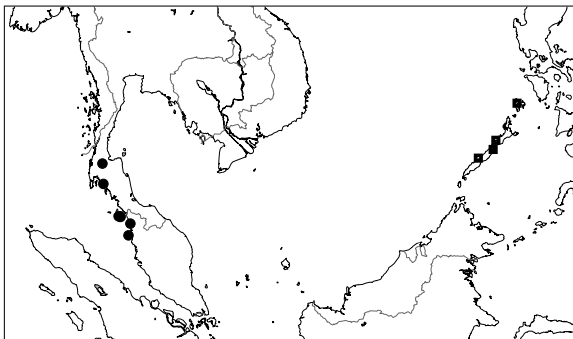
a. subsp. pubescens — Fig. 6; Plate 5a, b; Map 13

Plants 35–150 cm tall. Petiole of *cauline leaves* 2–48 mm long; lamina 30–140 by 14–46 mm. *Inflorescences* ± erect; bracts 3–9.7 by 1.7–4 mm.

Distribution — Thailand and West Malaysia.

Ecology — Flowering: November to April.

Note — The morphological distinction between the two subspecies of *Microrhodium pubescens* is rather insignificant. According to Regalado & Soejarto (1997), subsp. *elmerianum* in contrast to subsp. *pubescens* has yellowish brown pubescent sessile



Map 13. Distribution of *Microrhodium pubescens* C.B. Clarke subsp. *pubescens* (●) and *M. pubescens* subsp. *elmerianum* (Regalado & Soejarto) Thiv (■).



Fig. 6. *Microrhium pubescens* C.B. Clarke subsp. *pubescens*. a. Habit; b. flower; c. calyx; d. corolla with stamens; e. gynoecium (a, b: Robinson 6184; c–e: Henderson 29184).

leaves and glabrous inflorescences. However, the range of leaf size of both subspecies overlaps and differences in the indumentum could not be confirmed. Still, subsp. *elmerianum* is distinguished by its pendulous inflorescences and somewhat shorter petioles. This together with their geographical distinction is the basis for their recognition as subspecies (cf. Du Rietz, 1930).

b. subsp. *elmerianum* (Regalado & Soejarto) Thiv, *comb. & stat. nov.* — Map 13

Microrhodium elmerianum Regalado & Soejarto (1997) 77. — Type: Soejarto *et al.* 6499 (holo F; iso A n.v., PHN n.v.), Philippines, Palawan Island, Puerto Princesa, Bacungan hills, slopes above Nagtabon beach, 9° 51' N, 118° 37' E, 50–100 m, 9 April 1989.

Plants 35–110 cm tall. Petiole of cauline *leaves* 3–20 mm long; lamina 35–80 by 16–30 mm. *Inflorescences* mostly \pm pendulous; bracts 3–6 by 1.2–3 mm.

Distribution — Palawan.

Ecology — Flowering: February to August.

6. PHYLLOCYCLUS Kurz — Fig. 7

Phyllocyclus Kurz (1873) 235. — Type: *Phyllocyclus helferianus* Kurz.

Canscora Lam. (1785) 601 p.p.

Euphorbiopsis H. Lév. (1911) 446. — Type: *Euphorbiopsis lucidissima* (H. Lév. & Vaniot) H. Lév.

Annual or perennial, erect, glabrous *herbs*; stems apically branched, terete usually without ridges. Rosette or most basal cauline *leaves* present, usually free, ovate to broadly ovate; cauline leaves perfoliate, orbicular, with several main veins, apex obtuse. *Inflorescences* axillary, few-flowered, lax cymes; bracts perfoliate, orbicular or funnelshaped. *Flowers* (except calyx) pentamerous, mostly sessile, rarely pedicellate, without bracteoles. *Calyx* penta- or tetramerous, inflated urceolate or tubular, without wings, persistent. *Corolla* actinomorphic, urn-, funnel- to salvershaped, white-yellow to cream-coloured; tube longer than lobes. *Androecium* isomorphic or anisomorphic with filaments of different length; stamens inserted equally in central or upper part of

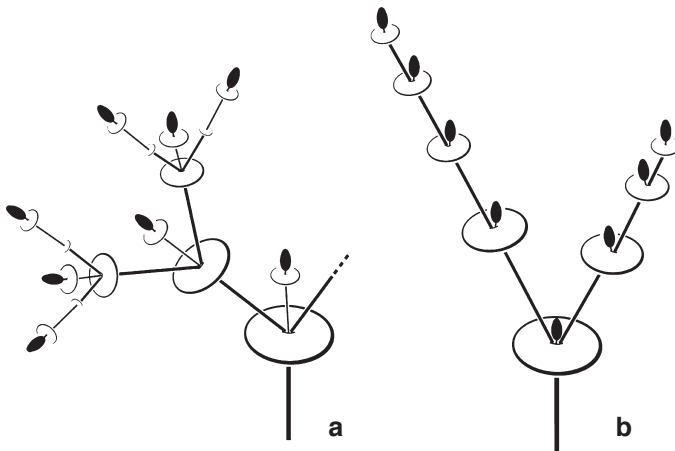


Fig. 7. a. Dichasial and b. monochasial inflorescences of *Phyllocyclus*.

corolla tube; filaments broadened at the base; anthers sagittate, deciduous. *Ovary* ovate to obovoid; surface smooth or constricted; stigmatic lobes rounded. *Seeds* irregular in shape, subglobose to elliptic; testa cells irregular in shape, oriented irregularly; anticlinal walls undulating, multiply folded; cuticle with scaly exudates.

Distribution — Five species from Burma to southern China.

Notes — With its equal stamen insertion, its mostly pentamerous corollas, and its perfoliate, orbicular cauline leaves, this genus is clearly distinct from *Canscora* s.str. By sharing these characters *Canscora lucidissima* and *C. petelotii* have been transferred to *Phyllocyclus*.

Unfortunately, species of *Phyllocyclus* seem to be extremely rare and have been collected only a few times. Therefore, the full range of variation in these species is yet to be determined.

KEY TO THE SPECIES OF PHYLLOCYCLUS

- 1a. Flowers mostly in monochasia. Flowers without minute prophylls (Fig. 7) 2
 - b. Flowers mostly in dichasia. Some flowers with minute perfoliate prophylls (Fig. 7) 3
- 2a. Filaments of \pm equal length. Corolla < 9 mm long **6.1. P. helferianus**
 - b. Some filaments up to 3 times longer than others within one flower. Corolla > 14 mm long **6.4. P. parishii**
- 3a. Filaments of \pm equal length. Plants probably perennial **6.2. P. lucidissimus**
 - b. Some filaments up to 3 times longer than others within one flower. Plants annual 4
- 4a. Corolla < 10 mm long. Bracts funnelform. Calyx urceolate . **6.3. P. minutiflorus**
 - b. Corolla > 14 mm long. Bracts orbicular. Calyx tubular **6.5. P. petelotii**

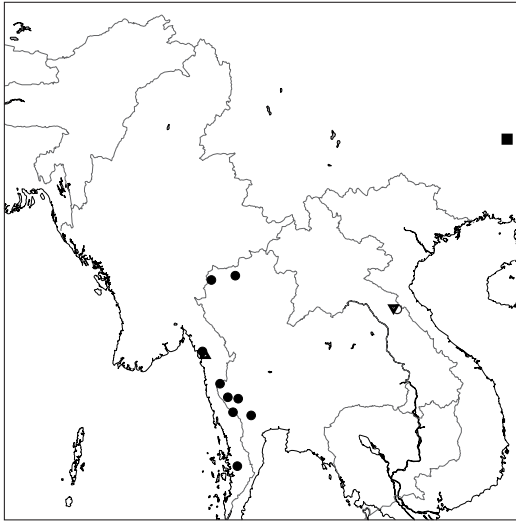
6.1. Phyllocyclus helferianus Kurz — Plate 5g, h; Map 14

Phyllocyclus helferianus Kurz (1873) 235. — *Canscora helferiana* (Kurz) C.B. Clarke (1875) 432.
— Type: *Helper* 5816 (lecto K, designated here; iso A), Tennasserim and Andamans, Three Pagoda Pass, 1837.

Annual *herbs* 9–47 cm tall. Rosette *leaves* broadly ovate, 18 by 9 mm, early deciduous, apex cuspidate; cauline leaves 9–22 by 18–27 mm. *Inflorescences* axillary, 1–15-flowered, lax cymes (mostly monochasia); bracts orbicular 5–10 by 9–18 mm, without small prophylls (Fig. 7). *Flowers* (except calyx) pentamerous, (rarely tetramerous), sessile. *Calyx* tetramerous, inflated urceolate, 7–8 by 4–5 mm; tube 5.5–7 mm long; lobes triangular, 1 by 1.3 mm, apex acute. *Corolla* urn- to salvershaped, 7–9 mm long, cream-coloured to yellow-white; lobes slightly spatulate, apex obtuse, 1–2.3 by 0.8–1.1 mm. *Androecium* isomorphic, filaments of equal length, 2.2–2.3 mm long; anthers 1 by 0.4 mm. *Ovary* ovate with an apical annulus, surface constricted, 2.9–4.5 by 1.1–3 mm; style up to 5.5 mm long; stigmatic lobes rounded, 0.3 by 0.4 mm. *Capsule* oblong, 4 by 3 mm. *Seeds* c. 0.23 by 0.18 mm.

Distribution — Thailand and Burma.

Ecology — Wet evergreen forest; on calcareous rocks or wet ground. Altitude 100–1200 m. Flowering: September to February.



Map 14. Distribution of *Phyllocyclus helferianus* Kurz (●), *P. lucidissimus* (H. Lév. & Vaniot) Thiv (■), *P. minutiflorus* Thiv (○), *P. parishii* (Hook.f.) Kurz (▲) and *P. petelotti* (Merr.) Thiv (▼).

6.2. *Phyllocyclus lucidissimus* (H. Lév. & Vaniot) Thiv, *comb. nov.* — Plate 6c, d;
Map 14

Euphorbia lucidissima H. Lév. & Vaniot (1906) 763. — *Euphorbiopsis lucidissima* (H. Lév. & Vaniot) H. Lév. (1911) 446. — *Canscora lucidissima* (H. Lév. & Vaniot) Hand.-Mazz. (1931) 234. — Type: Léveillé 1881 (holo E), Sud de Lin Fan, route des rocher.

Apparently perennial *herbs* 10–30 cm tall. Rosette *leaves* ovate, 1.5 by 0.7 mm, early deciduous, apex acute; cauline leaves 11–16 by 21–24 mm. *Inflorescences* axillary, 3–12-flowered, lax cymes (mostly dichasia); bracts orbicular, 5–8 by 10–13 mm, with small prophylls (Fig. 7). *Flowers* (except calyx) pentamerous, sessile. *Calyx* tetra- or pentamerous, inflated urceolate, 4.7–6 by 2.8 mm; tube 4 mm long; lobes triangular, 1.5 by 1.5 mm, apex acute. *Corolla* urn- to salvershaped, 6–8 mm long, white or pale yellow; lobes slightly spatulate, 1.9–2 by 1 mm, apex obtuse. *Androecium* isomorphic, filaments of equal length, 2–2.3 mm long; anthers 0.7–1 by 0.4 mm. *Ovary* ovate, surface constricted, 3.5–5 by 1.8 mm; style up to 3.5 mm long; stigmatic lobes rounded, 0.3 by 0.3 mm; *Capsule* ovate to oblong, 3.5 by 2.5 mm. *Seeds* c. 0.19 by 0.13 mm.

Distribution — China.

Ecology — Limestone rocks and slopes. Altitude 1000–1200 m. Flowering: March, August.

6.3. *Phyllocyclus minutiflorus* Thiv, *spec. nov.* — Map 14

Diagnosis: Species nova *P. petelotii* (Merr.) Thiv similis sed differt corolla parviore et bracteis infundibularibus. — Typus: *Pételot* 3857 (holo NY), Si Cammon, Village de Cham, sol très humide d'une grotte sur un rocher calcaire, 160 m, Dec. 1930.

Probably annual *herbs* 12–23 cm tall. Basal cauline *leaves* ovate to broadly ovate, 35–37 by 24–30, petiolate, petiole 4–10 mm long, apex obtuse; cauline leaves 7–10 by 14–23 mm. *Inflorescences* 3–8-flowered, lax cymes (mostly dichasia); bracts fun-

nelshaped, 5–6 by 7–11 mm, with small prophylls (Fig. 7). *Flowers* (except calyx) pentamerous, pedicellate, pedicels up to 0.5 mm long. *Calyx* tetra- or pentamerous, tubular to urceolate, 6 by 2.2–2.8 mm; tube 4.5 mm long; lobes triangular to needle-shaped, 1.5 by 1 mm, apex acuminate. *Corolla* funnel- to salvershaped, 7 mm long, probably white or pale yellow; lobes wedgeshaped to broadly spatulate, 2 by 1.8–2 mm, apex obtuse. *Androecium* anisomorphic with filaments of different length, 1–3 mm long; anthers 0.8 by 0.3 mm. *Ovary* elliptic to ovate, surface smooth, 3 by 2.2 mm; style up to 4 mm long; stigmatic lobes rounded, 0.3 by 0.3 mm. *Capsule* oblong, 4 by 2.5 mm.

Distribution — This species is only known from two collections in Laos.

Ecology — Calcareous rocks. Flowering: December.

Etymology — The name refers to the smaller flowers of *P. minutiflorus* compared with the remainder of this genus.

Note — With its filaments of differing length, *P. minutiflorus* is closely related to *P. petelotii*, but differs from this and other species by having much smaller flowers and funnelshaped bracts.

6.4. *Phyllocyclus parishii* (Hook.f.) Kurz — Plate 6a, b; Map 14

Phyllocyclus parishii (Hook.f.) Kurz (1873) 235. — *Canscora parishii* Hook.f. (1864) t. 5429.

— Type: *Parish 451* (A, E, K), Moulmein, limestone rocks, 1862.

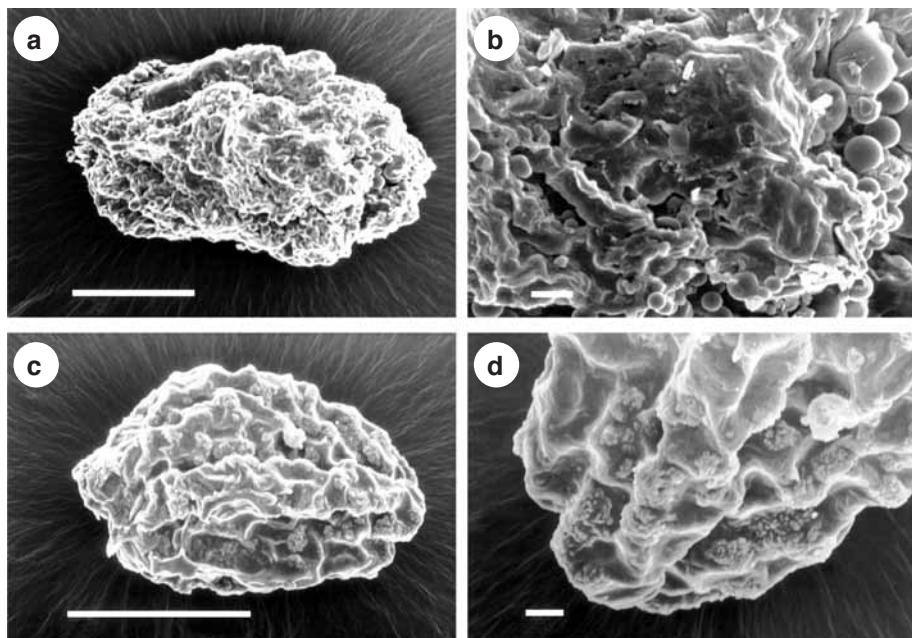


Plate 6. SEM photographs of seed coat structures. — a, b. *Phyllocyclus parishii* (Hook.f.) Kurz (*Gower s.n.*); c, d. *Phyllocyclus lucidissimus* (H. Lév. & Vaniot) Thiv (*Huang s.n.*). — Scale bars: a, c = 100 µm; b, d = 10 µm.

Annual *herbs* 20–40 cm tall. Basal cauline *leaves* free or perfoliate, early deciduous; cauline leaves 16–38 by 26–60 mm. *Inflorescences* mostly axillary, 4–10-flowered, lax cymes (mostly monochasia); bracts orbicular, 6–12 by 10–25 mm, without small prophylls (Fig. 7). *Flowers* pentamerous, pedicellate; pedicels up to 2 mm long. *Calyx* inflated urceolate, 9–11 by 4–5 mm; tube 6–8 mm long; lobes triangular, 3 by 2 mm, apex acute. *Corolla* \pm salvershaped, 14–19 mm long, white or pale yellow; lobes spathulate, 4–6 by 4–7 mm, apex obtuse. *Androecium* anisomorphic with filaments of different length, 2–7 mm long; anthers 3 by 0.6 mm. *Ovary* oblong-ovate with an apical annulus, surface striate, 4.5 by 2 mm; style up to 7 mm long; stigmatic lobes rounded, 0.8 by 0.6 mm. *Capsule* oblong, 6 by 3 mm. *Seeds* c. 0.29 by 0.16 mm.

Distribution — Burma.

Ecology — Limestone rocks.



Fig. 8. *Phyllocyclus petelotii* (Merr.) Thiv. a. Habit; b. calyx; c. corolla; d. stamens; e. gynoecium (all: Pételot 4327).

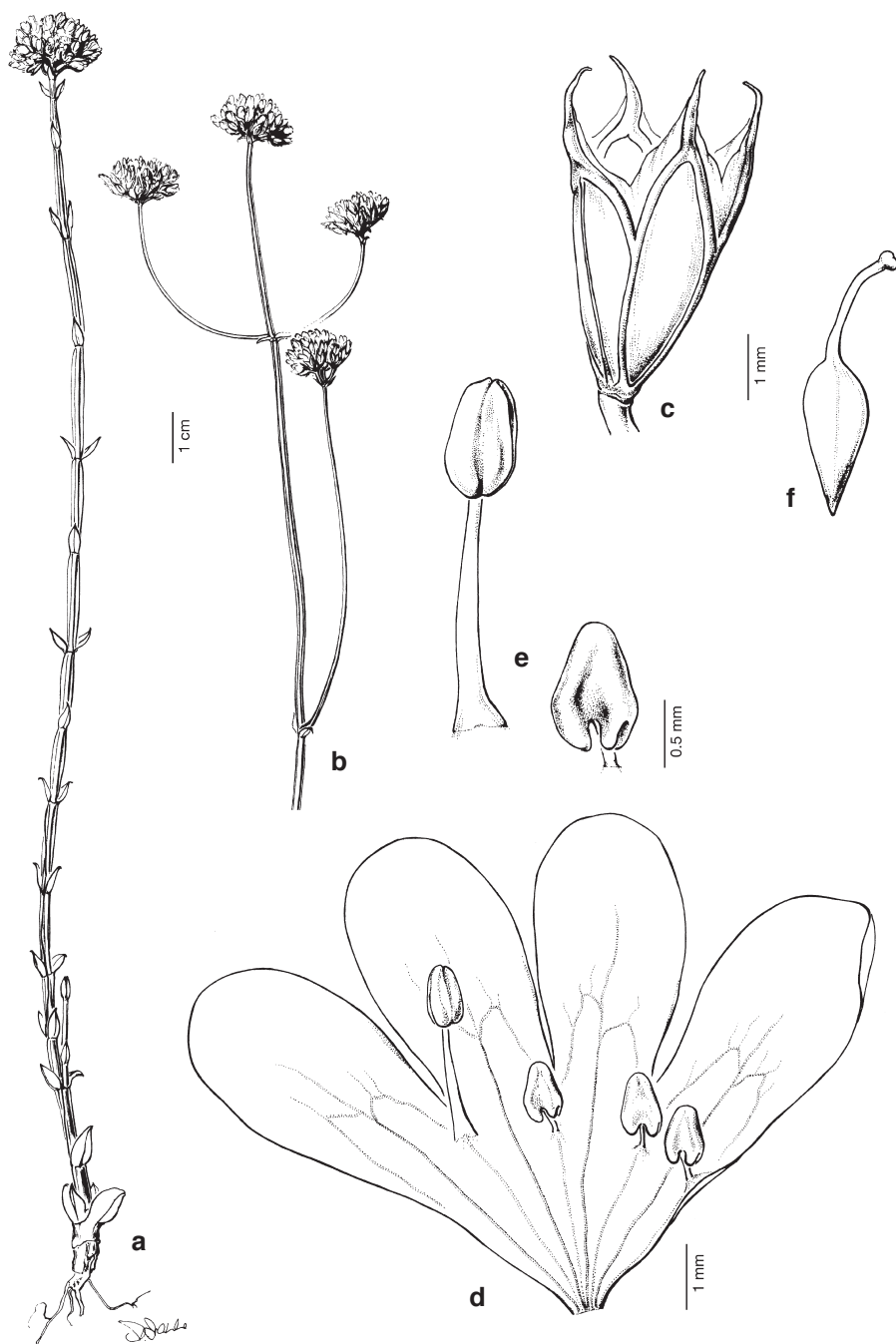


Fig. 9. *Schinziella tetragona* (Schinz) Gilg. a. Habit; b. inflorescence; c. calyx; d. corolla with stamens; e. stamens of anisomorphic androecium; f. gynoecium (a: Richards 4721; b: Champluvier 5136; c–f: Milne-Redhead 4394).

6.5. *Phyllocyclus petelotii* (Merr.) Thiv, *comb. nov.* — Fig. 8; Map 14

Canscora petelotii Merr. (1938) 63. — Type: *Pételot 4327* (holo P n.v.; iso NY), Laos, Si Cammon, Village de Kouan Pha Vang.

Annual *herbs* 5–9 cm tall. Basal cauline *leaves* ovate, 19–20 by 13–18, apex acute; cauline leaves 6–13 by 8–32 mm obtuse. *Inflorescences* few-flowered, lax cymes (mostly dichasia); bracts orbicular, 7–8 by 11–17 mm, with small prophylls (Fig. 7). *Flowers* (except calyx) pentamerous, pedicellate; pedicels up to 2 mm long. *Calyx* trimerous, tubular, 6–7 by 2.2 mm; tube 5–6 mm long; lobes triangular, 1.5 by 1.8 mm, apex acute. *Corolla* funnel- to salvershaped, 14–15 mm long, white or pale yellow; lobes ovate to spatulate, 7 by 4–4.5 mm, apex obtuse. *Androecium* anisomorphic with filaments of different length, 1.8–6.2 mm long; anthers 1.7 by 0.8 mm. *Ovary* obovoid, surface smooth, 2.5 by 1.5 mm; style up to 4 mm long; stigmatic lobes rounded, 0.3 by 0.3 mm. *Capsule* oblong, 4.5 by 3 mm.

Distribution — Laos.

Ecology — Calcareous rocks. Flowering: December.

7. SCHINZIELLA Gilg

Schinziella Gilg (1895) 74. — Type: *Schinziella tetragona* (Schinz) Gilg.
Canscora Lam. (1785) 601 p.p.

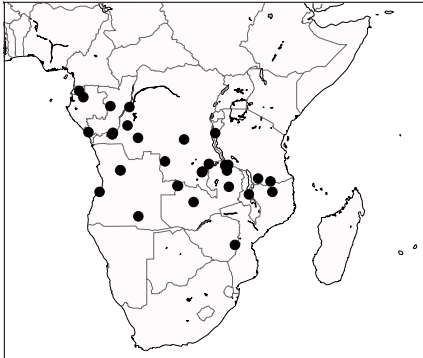
Perennial, erect, glabrous *herbs*; stems basally and apically sparsely branched, quadrangular, strongly winged. Basal cauline *leaves* free, sessile, deciduous, lamina with one main vein, elliptic, base shortly attenuate, apex obtuse or acute; upper cauline leaves free, sessile, lamina with one main vein, broadly lanceolate to triangular, apex acute. *Inflorescences* axillary and terminally, many-flowered, dense, headlike cymes; bracts free. *Flowers* tetramerous, pedicellate, sometimes with two long lanceolate bracteoles. *Calyx* funnelshaped, with ridges at the margin of each sepal, persistent; lobes triangular to blunt with a point. *Corolla* actinomorphic, funnellform, mostly yellowish creamish; tube \pm as long as the lobes. *Androecium* anisomorphic (Fig. 9d), stamens inserted in upper or lower part of corolla tube; one or rarely two upper stamens with longer filament and larger anther than the remaining lower stamens; anthers sagittate, persistent. *Ovary* oblong to elliptic; stigmatic lobes rounded to oblong. *Fruit* an oblong capsule. *Seeds* irregular in shape, angular, often cubical to rectangular and with shallowly sunken sides; outer testa reticulate, with shallow cells; testa cells irregularly polygonal, oriented irregularly; anticlinal walls prominent, mostly straight; cuticle smooth.

Distribution — One species in tropical Africa.

7.1. *Schinziella tetragona* (Schinz) Gilg — Fig. 9; Plate 4a, b; Map 15

Schinziella tetragona (Schinz) Gilg (1895) 74. — *Canscora tetragona* Schinz (1891) 338. — Type: *Mechow 418* (lecto Z, designated here; iso BR, G), West Afrika, Malange, 17 Feb. 1891.

Plants 21–62 cm tall with woody rhizome; stems with wings up to 2 mm wide. Basal cauline *leaves* 8.5–22 by 5–17 mm; upper cauline leaves 4–8.9 by 0.9–3.6 mm. *Inflorescences* 20–40-flowered dense cymes; bracts lanceolate, 2.8–8 by 0.3–2.5 mm; pedicels 0–3 mm long. *Calyx* 5–7 by 2.5–3 mm; tube 2.9–4.5 mm long; lobes 2–3



Map 15. Distribution of *Schinziella tetragona* (Schinz) Gilg.

by 1.5 mm long. *Corolla* 6–9 mm long; lobes obovate to broadly elliptic, 3.5–5.8 by 1.8–2.3 mm. Filament of the upper *stamen* 0.9–1.9 mm long, anther 0.8–0.9 by 0.4–0.7 mm; filaments of the lower stamens 0.3–0.4 mm long, anthers 0.8–1 by 0.4–0.7 mm. *Ovary* 2.5–3.4 by 1.1–1.4 mm; style 1–2.7 mm long; stigmatic lobes 0.4 by 0.3 mm. *Fruit* 3–3.5 by 1.8–2 mm. *Seeds* 0.23–0.34 by 0.14–0.21 mm.

Distribution — Tropical Africa.

Ecology — Wet places in sometimes flooded grasslands, swamps and marshes; sandy soil. Altitude 400–1900 m. Flowering: throughout the year.

Note — *Schinziella tetragona* is variable in its flower size.

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I would like to thank Joachim W. Kadereit (Mainz, Germany) and an anonymous reviewer for precious and helpful comments on the manuscript. I owe thanks to Doris Franke (Mainz, Germany) for preparing the figures and plates and to Peter Leins and Birgit Volz (Heidelberg, Germany) for accession and support to SEM analyses. I am grateful to Werner Greuter (Berlin, Germany) who helped clarify some nomenclatural problems and to Ferry Bouman (Amsterdam, The Netherlands) who reviewed the seed descriptions. Finally, I thank the directors of A, B, BKF, BM, BO, BR, C, E, F, FWM, G, HBG, K, KLU, KUN, L, MEL, MICH, MO, NSW, NY, P, PE, PH, PNH, S, SING, SRGH, TUB, U, US and Z for the loan of their material.

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IDENTIFICATION LIST

The abbreviations behind the collector numbers refer to the following taxa:

cal = <i>Canscora alata</i>	dp = <i>Duplipetala pentanthera</i>
can = <i>Canscora andrographioides</i>	hd = <i>Hoppea dichotoma</i>
cc = <i>Canscora concanensis</i>	hf = <i>Hoppea fastigiata</i>
cd = <i>Canscora diffusa</i>	mpe = <i>Microrphium pubescens</i>
ch = <i>Canscora heteroclita</i>	subsp. <i>elmerianum</i>
cm = <i>Canscora macrocalyx</i>	mpp = <i>Microrphium pubescens</i>
cp = <i>Canscora perfoliata</i>	subsp. <i>pubescens</i>
cr = <i>Canscora roxburghii</i>	ph = <i>Phyllocyclus helferianus</i>
cs = <i>Canscora schultesii</i>	pl = <i>Phyllocyclus lucidissimus</i>
crc = <i>Cracosna carinata</i>	pm = <i>Phyllocyclus minutiflorus</i>
crg = <i>Cracosna gracilis</i>	ppa = <i>Phyllocyclus parishii</i>
crx = <i>Cracosna xyridiformis</i>	ppe = <i>Phyllocyclus petelotii</i>
dh = <i>Duplipetala hexagona</i>	st = <i>Schinziella tetragona</i>

More information to the collections in Thiv (2000).

Abbayes 882: st — Abbe 10117: dp — Achten 113: st — Ahern 2449: cd; 3382: cd — Aké Assi 6620: cal; 7512: cd; 7554: cd; 14422: cd; 14519: cd — d'Alleizette 68: pl; 492: hd; 1216: cd; 4944: cal — Altmann 538: cd — Anderson 155: cd; 2849: dp — Anglade 1197: ch — Archbold

- 1411: cal; 2860: cal — Argent 980: cal — Armit 652: cd — Arnott 2562: cd; 2567: cp; 8564: cal — Arora 6042: cd.
- Backer 5015: cd; 20267: cm; 20269: cm; 27062: cm; 27485: cm; 27689: cm; 27734: cm; 27784: cm; 29570: cm; 30006: cm; 32657: cd — Bakhuizen van den Brink 960: cd; 3258: cd; 3466: cd — Balansa 1037: can; 1038: can — Balapure 542: cal — Banks & Solander 1770: cd — Banskuti 265: ch — Barber 5687: cp — Barnes 276: cd; 649: cr; 652: cd; 674: cd; 777: cal; 967: cd; 968: cd; 970: cp; 1658: hf; 1835: cr; TV2: cr — Baron 9976: cd — Barter 806: cd — Baum 642: st — Bavicchi 315: st; 481: cal — Bear 16979: can — Beddome 5360: cd; 5364: ch; 5368: cd; 5369: cd; 5370: cp — Bedi 1517 p.p.: cal — Bell 5730: cp — Benson 341: st — Bequaert 7337: st; 7833: cal — Berhaut 1481: cd; 1860: cal — Best 21244: dp; 21277: dp — Bhattacharyya 12882: cd — Bingham 9408: cd — Blatter 5484: cd — Boivin 2080: cal — Borgesen 202: cp — Bosser 9746: cd; 18009: cal — Bourne 1611: ch; 2176: hd; 2539: cr; 3415: cd; 6289: cd — Bradford C5053: dp — Bremer 1795: can — Breyne 453: st — Bruce 4: cd — Brummit 14066: st; 17001: st; 18369: cd; 18374: cal — Buchanan 25: cd — Bunchuai 1385: ph — Burkill 2256: dp; 2554: dp; 3361: can — Burt 6267: st — Buwalda 8041: cd — Byrnes 2603: cd.
- Campbell 10: cd; 82: cd — Carlier 349: st — Celestino 4438: cd — Champluvier 5136: st — Chancellor 258: cal — Charoenphol 4229: can — Chattaryie 5736: cal — Chen 7115: can — Cherian 111320: cc — Chermisrivathana 1569: crc — Chevalier 5981: cal — Chin 1728: mpp — Ching 6635: pl; 7866: can; 7868: can — Chun 43898: can — Clarke 6462: can; 7759: cal; 10177: cal; 10358: cd; 14603: can; 16911: cd; 20896: hd; 24685: cd; 24851: cal; 24877: cal; 25020: cd; 31871: hd; 34174: cd; 34622: cd; 37057: cal; 37325: can — Clarkson 6092: cd — Clemens 4229: can — Coert 490: cm; 495: cm; 709: cd; 1144: cd — Conklin 37917: cd — Cook 66: hd; 236: hf; 1029: hf; 5185: hf; 5281: hf — Coombe 36: cd — Cooray 70020226R: ch — Corner 37857: mpp — Coûteaux 1048: st — Cramer 4830: cal; 4883: hf; 4913: cr; 4926: cr; 5047: hf; 5050: ch; 5058: ch; 5075: ch; 5087: ch; 5092: hf; 5099: cr; 5100: cal; 5102: cd; 5104: cr; 5126: cal; 5129: ch; 5143: hf; 5168: cal; 5191: cr — Cuming 1107: cd — Cunningham 83: cd — Curtis 2516: dp; 3779: dp.
- Da Graca Epirito Santo 2842: cal — Danser 6457: cd — Davis 69141: dp — Dawe 71: cal — De Giorgi 200: st — De Voogd 764: cm; 2570: cd; 4442: cd; 4685: cd; 14401: cd; 15354: cd; 15394: cd — De Wilde 2: cal; 4841: cal — Decary 19212: cal; 19213: cal; 19253: cal — Deighton 3307: cd; 4042: cal; 4408: cal; 4462: cal — Deng 7147: can; 7989: can — Devred 17: cd; 132: cal — Ding 1219: cd — Dorelo 200: cm; 351: cm — Drake 558: cal — Drummond 1773: cd; 3966: cal — Dunlop 4577: cd — Duthie 4752: cd; 6427: cd; 8338: cd; 8350: hd; 9572: hd; 22317: cd.
- East Hainan Expedition 45: can; 403: can — Edaño 26823: cd — Ekwuno 76975: cal — Elliot 4505: cd — Elmer 8476: cd — Erlanson 5236: cd; 5261: cd — Espirito Santo Exploracoes Botanicas 2365: cd — Esquirol 2650: pl; 3502: cd — Evrard 1911: cal; 6603: st.
- Faden 77/81: ch — Fanshawe 4462: cd; 6997: cd; F6652: cd; F6897: cd; F11423: cd — Faulkner 99: cd; 304: cal; 2677: cal; 4118: cal — Fay 5191: cal — Feller B8: cal; B10: cd — Fenix 28252: cd; 30078: cd — Fernandes 444: cd; 529: cd; 556: cd; 605: cd; 660: cd; 906: cd — Fischer 3215: cp — Flamigni 92: cal; 281: cd; 406: cal — Fosberg 35055: cd — Fox 12577: mpp — Frake 36300: cm — Franck 1029: dp — FRI 1632: dp; — Friedberg 418: cd — Fries 178: cd — Friis 531: cal.
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